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SAMUEL SMITH

GENERAL EDITOR





# HANDBOOK OF GENERAL PSYCHOLOGY

A SUMMARY OF ESSENTIALS AND  
A DICTIONARY OF TERMS

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## Preface

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THE PURPOSE of this volume is twofold. *First*, the subject matter of general psychology has been summarized for the convenience of the general reader who wishes to understand the behavior of the normal adult individual. This handbook provides for any reader an introduction to the aims, methods, and principles of psychology, which as a science investigates not only what man does but also what he experiences in everyday life. *Second*, the book has been arranged to serve as a guide for the college student who studies psychology for the first time. The effort has been made to set forth the specific aims, methods, facts, and explanations pertinent to the needs of the beginning student.

It has been the purpose of the authors to summarize, without the inclusion of numerous details, the basic facts and principles which describe and explain human behavior. To do this the most significant and essential materials in general psychology have been highlighted. The student can profitably read any chapter in the volume in conjunction with the corresponding chapter in the standard texts used today in colleges and universities. The book should also be useful to those teachers of introductory psychology who do not wish to adhere to a specific and detailed text but prefer to develop their course in connection with selected references.

In line with these purposes, the volume has been organized as follows.

*First*, each chapter presents a summary of the generally accepted facts on the problem or topic in question. Theories and laws have been set forth briefly in order to ease the mastery of those facts and explanations which compose the subject matter of general psychology. Classical experiments, each of which should

be well known to the student who has studied psychology, have been summarized and their significance indicated.

*Second*, a dictionary section has been included. In this section, the technical terms most frequently used in psychology and related disciplines have been listed alphabetically and defined in a vocabulary suited to the needs of the general reader and the college student.

*Third*, the volume includes a description list of contributors to psychology. Inasmuch as newspapers and popular magazines often carry articles which refer to psychological investigations, a knowledge of the life and works of these men and women who study man's behavior has educational and cultural value. The section on contributors includes only those contributors whom the beginning student is likely to meet in his study of standard textbooks and other reference sources. Many other equally important contributors will be met in more advanced courses or in further reading of detailed source-books.

*Fourth*, a list of references to basic texts suitable for study by any interested reader has been included. These books are in general use today. For the reader's information the date of publication and the length of each book are given.

The following suggestions are made for the efficient use of this volume. *First, skim the chapter before careful study.* This procedure ensures understanding of the way in which each chapter has been developed. *Careful reading should follow.* Each new term should be listed and defined by reference to the text and to the dictionary of technical terms. By virtue of the fact that every science includes new terms, mastery of these words is essential for adequate comprehension. Careful, continued use of both the dictionary and the text is advised.

During the study of each chapter the reader will do well to ask himself questions about the subject matter. In this connection, the American psychologist Gates, has shown that testing one's self during reading is a far more efficient way to master the material than is more passive and continuous reading. Self-testing is facilitated by the series of questions included at the close of each chapter. Answers to these questions are to be found in the chapter. To test his mastery and understanding of the

material, the reader should attempt to answer these questions. If he is unable to answer all of them after two or more readings, selective review of the chapter and a search for the correct answers may be made. Since logical learning requires less time and effort than rote learning, and since one remembers meaningful material longer than meaningless subject matter, the reader should understand why each correct answer is correct. The search for understanding, rather than parrot-like repetition (rote learning) is the best way to study psychology.

A list of references to which the reader is referred for extended and, in some instances, more advanced treatment, is found at the close of each chapter. Each reference has been described briefly to aid the reader in selecting the books adapted to his needs.

This volume is, therefore, dedicated to the student who wishes to know in a summary way what psychology is, how the psychologist works in his laboratory, and what psychological facts and principles mean in relation to everyday life.



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PART ONE

*Summary of Essentials*

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## CHAPTER ONE

# *Introduction to General Psychology*

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### HISTORICAL INTRODUCTION

PSYCHOLOGY\*, as the science\* of behavior, is a comparatively recent development. The word *psychology* is derived from the Greek, in which *psyche*\* means soul\* and *logos* means study. Early writers defined the subject in this way (as the study of the soul). Today, however, the emphasis is placed more upon what man does, that is, how he behaves as shown by experiments\* conducted in the psychological laboratory. The first laboratory of this kind was opened by Wilhelm Wundt\*, the father of experimental\* psychology, in 1879 at the University of Leipzig, Germany. By 1900 more than a score of these laboratories had been founded in the United States.

The historical developments which led man to study the behavior\* of his fellows under controlled conditions of the laboratory are indeed numerous. They lead us to the earliest records left by primitive peoples. To highlight the development of psychology through the ages, a series of chronologically arranged periods is characterized as follows:

1. *The Early Greek And Roman Period.* Primitive man believed in the doctrine of animism\*. He used this notion to account not only for his own behavior but also for thunder storms, seasonal changes, and falling rocks. All animate and inanimate

\* Note: Terms followed by an asterisk are defined or discussed in Part II, the dictionary section. Names followed by an asterisk are discussed in Part III.

objects were believed to be inhabited and controlled by animistic forces or spirits\*. Such directing agencies came eventually to be called mind\*. These animistic interpretations of nature were handed down to the early Greek and Roman philosophers. They, however, were interested not only in the mind\* of man, but also in the nature of things about them. Some came to explain mind and material objects in terms of a single force or causal agent. This notion is the forerunner of *monism*\*, as it is known today. Others were just as positive that several directive agents are at work in nature. These thinkers believed, therefore, in a *pluralism*\* of agents to account for mind and matter. Empedocles (ca. 490-435 B.C.), to illustrate, assumed that both mind and matter could be accounted for by the combination of four elements: earth, air, fire, and water. Hippocrates\* (ca. 460-370 B.C.), the "father of medicine," appears to have been indebted to this pluralistic dogma when he formulated the first classification of human temperaments\*: the *sanguine*, *choleric*, *melancholic*, and *phlegmatic*. He assumed that man's temperament could be explained on the basis of a preponderance of any one of the four bodily humors or fluids designated as blood, yellow and black biles, or phlegm. Though Hippocrates and Galen\* (ca. 131-201 A.D.—the latter extended the former's classification) appear superficially to have been mistaken, it is interesting to note that they hit upon one important factor in human emotionality, namely, the structural and physiological aspect.

With the passing of the centuries, Greek philosophers showed greater concern for what came to be known as the mind and the universe. Plato\* (427-347 B.C.) concluded in *The Republic* that man is, for the most part, a product of his society. Plato's theory of knowledge is illustrative. "Ideas," as symbols of "things" in the universe had one of two possible origins. They were either (1) innate or (2) acquired by way of the sense\* organs. The interaction of two ideas\* from these different sources constituted, for Plato, the nearest approach to perfect knowledge. This interplay between entities assumed to be physical and those assumed to be mental or psychical heralds the approach of a *dualism*\* to account for mind and matter. Thus, for Plato,



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sensations\* of seeing occur when the fire within the eye meets and joins the fire from without. Society should be of such a nature that the sensations of external origins do not contaminate the sensations inherent within the soul.

Aristotle\* (384-322 B.C.), a student of Plato, not only continued to add to the knowledge of his day, but also came to influence both philosophy and modern science\* in many ways. In numerous writings he emphasized the biological and anatomical facts of nature. For evidence of his beliefs he cited his observations of life about him. Aristotle paved the way for the study of human nature by means of observation in the modern experimental manner. He stressed, more than did Plato, the primary role of the sense organs as ports of entry for sensations\* and ideas. His observations on man's capacity to remember are classic. Much later they became the bases for studies of learning and remembering. For him, recall\* of experiences is dependent upon a fragment of the original situation reinstating in "mind pictures" (images) the ideas related to the whole experience. Thus was born the principle of association\* which depended for its efficacy upon the factors of contiguity\*, similarity\*, and contrast\*.

The bases from which developed philosophy and science were thus laid down by the time of Aristotle\*. The problem of the relation between mind and matter had been raised. Monistic, pluralistic, and dualistic conceptions had already been offered to account for the nature of mind and the universe. The deductive\* (Plato) and the inductive\* (Aristotle) approaches to knowledge had now been formulated. The importance of the sense organs in the obtaining of truth had been expressed. The study of man and his experience had begun.

2. *The Dark Ages In The Western World.* With the advent of the Christian era and the political, economic, and religious upheavals which accompanied this period, little advance in philosophy and science was apparent in the Mediterranean World. Theologians had turned to the question of morals. Notable during this period, however, was St. Augustine (354-450 A.D.) who described in the *City of God* his own conscious experiences, and



who, hence, introduced the method of introspection\*. This technique was to become much later a major method for Wundt\* and Titchener\* in their development of experimental\* psychology. Not until the Renaissance began (approximately the sixteenth century) was there any marked interest in scientific endeavors. The teachings of Hippocrates\*, Plato\*, Aristotle\*, Galen\*, and others were still the standards for this long period.

3. *The Renaissance In Science.* With the revival of interest in learning came an impetus to study the world and the people in it. The influence of Francis Bacon\* (1561-1626) was great. As a philosopher it was he who emphasized in his *Novum Organum* the importance of the experimental and of the inductive method in science. Bacon, it is said, provided the scientists of the time philosophical justification for their investigations.

4. *The Development Of Psychology As A Science.* Experimental\* psychology developed from both philosophy and physiology. First, from English philosophy, there is noted in the 17th, 18th, and 19th centuries a return to Aristotle's doctrine of associationism, though expanded and modified by numerous English thinkers, notably Locke\* (1632-1704) and Hume (1711-1776). These writers concluded that man knows his environment and himself only through his sense\* organs. Ideas were no longer considered to be inborn. Though there were exceptions to this general doctrine, notably those by Bishop Berkeley (1685-1753), the role of associationism is still with us in modern psychology. The advent of Francis Galton\* (1822-1911) and his student Karl Pearson\* (1857-1936), however, did much to broaden what was to become the subject matter of psychology\*. With their studies of individual\* differences came the development of statistics\*, as a mathematical tool for the study of human and animal behavior. Galton and Pearson were indebted in their development of statistics to the pioneering work of the mathematicians Laplace (1786) and Gauss (1809) who developed the curve of normal\* distribution.

Additional German philosopher-psychologists, namely Wolff (1679-1754), Kant (1724-1804), and others, described the human

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mind as a series of pigeon-holes or compartments such as memory\*, reasoning\*, volition\*, intellect, and perception\*. This *doctrine of mental faculties\** was generally accepted without verification for many years. Educators, consequently, even in the early twentieth century, assumed that each so-called "faculty" could be readily trained by hard discipline. Though this notion is no longer accepted, the belief that a given subject in school is good because it is hard (that is, because it trains the mind) is a direct outgrowth of the faculty doctrine. This outmoded conception was carried to an extreme by the brilliant anatomist Gall (1758-1828) who claimed that he could locate and note the degree of development of these mental faculties by studying the protuberances of the skull. Gall thus developed and his follower Spurzheim (1776-1832) popularized the pseudo-science of phrenology\*. Today no one accepts these doctrines in the face of much negative evidence. Their persistence, however, is occasionally noted.

Second, from physiology\*, psychology received marked impetus for its gradual development during the 18th and 19th centuries. Because of the close relation between structure, as studied by the biologist, and function, as studied by the modern psychologist, the embryo science of human behavior\* progressed. The results from the studies of (1) spinal nerves by Magendie (1783-1855) and Bell (1774-1842), (2) the speed of nerve transmission by Helmholtz\* (1821-1894), (3) the sensory and motor areas of the cerebral cortex\* by Flourens (ca. 1822), Ferrier (1876), Fritsch and Hitzig (1870), combined to raise the question of the accuracy of the doctrine of mental faculties. The observation of the astronomer Bessel (1784-1846) to the effect that marked differences in speeds of reaction occurred when trained observers were asked to indicate the point in time at which a star was observed to cross a line within the telescopic field, led to further studies on individual\* differences. In addition, science in the nineteenth century was greatly stimulated by the publication of the theory of evolution in *The Origin of Species* (1859) written by the naturalist, Charles Darwin\* (1809-1882). The die was thus being

cast for the appearance of a new discipline—one which studied the behavior of man.

Among the earliest strictly psychological studies were those conducted by the physiologist, Ernst H. Weber\* (1795-1878). He investigated the relation between receptor and stimulus by determining how much more physical energy is necessary for man to judge a *second* stimulus\* just noticeably different from a *first*, or comparison stimulus.

Weber's findings have been formulated into what is known as Weber's\* Law (1834). Gustave T. Fechner\* (1801-1887), the German physicist, continued Weber's studies, delimiting the range of applicability of Weber's Law and formulating the principle mathematically. The physiologist, Johannes Müller (1801-1858), likewise, contributed to the study of problems more precisely psychological by his investigations of the manner in which man perceives visual distance. He also formulated the well known *Doctrine of Specific\* Nerve Energies*. This means that each sensory nerve always responds in a similar manner, regardless of the nature of the physical stimulus. Thus, the eye, if stimulated either by light waves or by a physical blow, will give rise to visual sensations. Müller's student, Herman von Helmholtz\* (1821-1894), developed a theory of hearing which, though modified, is still generally accepted today. Ewald Hering\* (1872) formulated a useful theory of color vision, a theory frequently mentioned in discussions of visual perception\*.

In summary, philosophy, physiology, mathematics, and physics are each known to have contributed in a material way to the development of the relatively new science\* of human behavior\*. These lines of influence and active investigation led to the opening of the first experimental laboratory, specifically dedicated to the study of psychology, by Wundt\* (1832-1920) in 1879. Wundt is known to modern psychology both as an active investigator and as an organizer of the new domain's subject matter. His laboratory was a center from which came many students trained to pursue their studies of man's experience and to teach psychology\*. Among his students who later taught in America were G. Stanley Hall\*, James McKeen Cattell\*, and E. B. Titchener\*.

5. *Psychology in America*. The development of psychology in

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the United States was due, first, to the pioneering efforts of William James\* (1842-1910). First, as a medical man, and then, as a philosopher-psychologist, James influenced American psychology for a long period. His classical studies on transfer\* of training raised doubt concerning the truth of the doctrine of mental faculties\* formulated long before by Wolff and Kant. His well known theory of emotional behavior stimulated physiological and psychological investigations. His *Principles of Psychology* (1890) is still frequently referred to by the serious student.

G. Stanley Hall\* (1844-1924), after his training with Wundt in 1883, opened the first psychological laboratory in the United States at Johns Hopkins University. He also founded the first journal for the publication of studies in psychology (*American Journal of Psychology*). Hall is known for his development of the questionnaire\* method used by him in his investigations pertaining to the behavior of children and adolescents\*. His two volume text entitled *Adolescence* can still be read with profit.

James McKeen Cattell\* (1860- ), Wundt's first assistant, studied and taught with Galton\* in England, returning to America shortly thereafter. His chief interest was in the application of the objective method to the measurement of reaction times.

6. *Recent Developments in Psychology.* The teachings of Wundt were ably represented by E. B. Titchener\* (1867-1927) at Cornell University. For Wundt and for Titchener the aim of psychology was to describe, *as is*, the states of consciousness\*. They relied upon St. Augustine's method of introspection\* which they perfected. By this means the *Structuralists*\*, so called because of their desire to study the structure of mind, learned much about human sensations\*, feelings\*, and other subjective phenomena.

The science, however, soon began to develop in new directions. John Dewey\* (1859- ) and James R. Angell (1869- ) expanded the study of psychology at the University of Chicago to include the human being in action, the organism in use. They were called *Functionalists*\* because they stressed the functional values of man's activities. They studied the "is-for" while Titchener studied the "is."



A third group headed in 1913 by John Watson (1878- ) decried the Wundtian emphasis upon subjective observation. They believed psychology could become as objective and exact as any other science only by use of the methods common to physics, chemistry, and biology. Watson's emphasis upon the study of what man does to the exclusion of what he experiences was called *Behaviorism*\*. In this way the objective method of observation came to be applied to the study of man in the psychological laboratory.

To counterbalance these divergent approaches a group of German psychologists led in 1912 by Max Wertheimer\* (1880- ) and aided by Koffka\* (1886-1941) and Köhler\* (1887- ) rejected the analytic approaches of the Structuralists, Functionalists, and Behaviorists. Wertheimer and his colleagues studied human and animal behavior by first investigating the reactions\* of their subjects to patterns of stimulation. This study of the *total situation* they believed yielded data which the analytic methods did not. Those who studied the whole situation as a phenomenon of experience in which the whole was always greater than the sum of its parts were called Gestalt\* psychologists. *Gestalt*, a German word, means pattern, synthesis, or configuration.

Still another interpretation which aided in the expansion of psychology was that of *purposivism* developed in 1923 chiefly by William McDougall\* (1871-1938). He emphasized in his experimental and theoretical analyses the purposive activity of man and animals. Thus, McDougall studied "What man wants to do" in order to understand the human mind.

A final influence upon the development of modern psychology has been that of psychoanalysis\*. Sigmund Freud (1856-1939), a physician and neurologist, was early convinced that many of his patients were not physically ill but rather were maladjusted and unhappy. He first tried hypnosis, developed earlier by Mesmer (1734-1815) and Braid (ca. 1795-1860), without marked success. Freud then developed the therapeutic agent known today as psychoanalysis. The three well known steps in this treatment by means of essentially psychological methods are called *catharsis*\*, *abreaction*\*, and *sublimation*\*. By urging his patient to tell

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him his troubles and anxieties Freud found the energies of the person could be directed into more worthwhile channels. The patient was then cured. In addition to working out this procedure, an ingenious theory to account for it was developed. Although this theory is often questioned today, the influence of psychoanalysis upon the development of scientific psychology has been marked. Freud emphasized (1) the application of the principle of determinism\* to the study of mental activities, (2) the need for the study of man's wants and tensions (motivation\*), and (3) the value of using the genetic\* method in the study of human behavior. These new developments within the study of human behavior have thus had a healthy and invigorating influence upon the science.

Hermann Ebbinghaus (1850-1909), the first student to investigate our ability to remember, once said (1885) that psychology had had a long period of development but a short history. That his observation was correct is borne out by the development of a new science through the centuries from a sort of primitive animism to the modern scientific study of man's behavior by the way of the psychological laboratory. That philosophy, physiology, physics, mathematics, and psychoanalysis have contributed to this development has been shown.

### THE BRANCHES OF PSYCHOLOGY

Within modern psychology several divisions of labor have already become established. Certain psychologists have studied the behavior of children. The results of their studies constitute *Child Psychology*. Data from other specialized approaches have been incorporated into the following branches: *Abnormal\**, *Adolescent\**, *Applied\**, *Comparative*, *Educational*, *Experimental*, *Race*, *Social\**, and *General*. Because it emphasizes the reactions\* of adults, *General Psychology*, as we should expect, draws information from its sister divisions.

### METHODS IN PSYCHOLOGY

1. *The Experimental Method*. By this method, the experimenter (designated as E) *observes* and *records* human behavior which

takes place under conditions controlled or established by the experimenter. These observations are made in two ways. First, E may ask his subject to *introspect\**, or to describe verbally or in writing his experiences during the experiment. Second, the experimenter (E) may watch the reactions of his subject and make use of instruments which automatically record what the subject does. This is the *objective\* method*. These two ways of observing are often combined to advantage in studies of the behavior of adults. With infants and animals, only the objective method can be used, because they are unable to talk. Often two groups of subjects are employed. These groups are equated as to sex, age, and other characteristics. One group is called the *experimental\** and the other the *control\** group. The effect, for example, of brain injury upon the behavior of animals in the experimental group can be compared with the behavior of those not injured but used as controls.

2. *The Genetic\* Method*. This method teaches the psychologist much of importance about growth\* and development\* of the organism. There are three different ways by which the genetic method may be applied. (1) The *longitudinal approach* is used in recording the responses of the subject (infant or child) day after day, just as is done in a diary or daybook. (2) In the *cross-section* approach the child is studied at regular intervals. Each Saturday, for instance, the child may be observed. After many children have been observed for many Saturdays, the experimenter can establish *norms\** or standards of development for specific acts of walking, talking, reading, smiling. By this method the psychologist learns at what age the average child may be expected to creep, walk, talk, or smile. (3) In the *training\* method* the effect of practice upon the development of behavior patterns is studied. Often twins\* are used as subjects so that one child acts as a control for the "experimental" twin. The second twin is given considerable training in selected activities, such as roller skating, while the control twin is not trained. This method, often called the *co-twin control*, has shown in general that the control twin rapidly catches up with his precociously trained brother.

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3. *The Case\* History Method*. This procedure is used in clinics for the study of the past life of the maladjusted and mentally ill individual. Discovery of what has happened to a patient may help in the diagnosis and treatment of the difficulty.

4. *The By-product\* Method*. This method involves the study of the writings of famous people, long since dead, in order that we may understand the culture of the period in which they lived. Such a procedure is closely related to *anthropology* which studies the origins and development of the human race.

5. *The Correlation\* Method*. This is a statistical approach for the analysis of data collected by experimental means. Its aims are twofold. First, the procedure is used to determine the degrees of relationship between man's performances (what he does) in different situations. For instance, if one is a good student in music, will one be equally good in mathematics? Second, the correlation method is used in making *factor\* analyses*. Many factors (determiners) are known to be causal in one's behavior at any one instant. What *independent* factors combine to produce the resulting response? Factor analysis tells us. Thus, to ascertain the causal factors which result in superior performance along a belt-line in a modern factory would aid the psychologist to select the best qualified men for the job.

### NATURE OF THE PSYCHOLOGICAL EXPERIMENT\*

Before the psychologist, investigating a specific problem about the behavior\* of an organism, carries out an experiment he is obliged to meet certain requirements or standards of inquiry. Definite rules of the *scientific\* method* (those ways whereby exact knowledge may be obtained) must be followed.

1. *Subjects* (Ss) are necessary. The subject\* in an experiment may be either human or animal. The method of observation which E employs will be determined by the nature of the problem and by the types of subjects used. In many experiments the subjects are selected in such a way that they are representative of the entire population. This selected group is known as a *random\* sampling*.

2. *Apparatus* is needed for the completion of a psychological study. Any instrument used in an experiment\* is designated as



apparatus. Very often instruments of complex construction are used (1) to control the strength of the stimulus\* and (2) to measure and to record automatically the magnitude and frequency of the subject's responses.

3. *An independent\* variable* is essential in any experiment in psychology. All conditions save one must be constant to determine the effect of changes in this one independent variable upon the subject's behavior, the *dependent\* variable*. To determine how keenly a subject hears (his auditory acuity), for example, the sound used would be the independent variable, and the responses of the subject would be the dependent variable.

4. *The raw\* scores* are grouped and studied. After the performances of the subjects\* have been measured these scores are at first carefully grouped. They are then analyzed by means of statistical techniques to disclose the average\* performance of the random sampling of subjects. *Statistics\** is thus a branch of mathematics which aids the psychologist to analyze and group the raw scores he has accumulated as a result of laboratory experiments.

5. *Explanations* are framed. The psychologist is not content with the mere accumulation of raw scores and of isolated facts about human and animal behavior. He wishes to explain these findings. To do so, an *hypothesis\** may be formulated which, as a tentative guess, has perhaps a fifty-fifty chance of being correct. With continued experimentation the psychologist may formulate a *theory\** or principle to explain his data. The theory, as distinguished from the hypothesis, has more evidence to support it and is, therefore, more likely to become a law. The *law\** in science, not to be confused with laws passed by legislative bodies, is a rule or principle which applies universally to the facts collected. Psychologists, therefore, formulate hypotheses, theories, and laws in explaining *how* it is that man does *what* he does.

## INTRODUCTORY PRINCIPLES IN PSYCHOLOGY

1. Every science assumes that each event or every reaction has antecedent causes or determiners. This is known in psychology as the principle of determinism\*. It tells us among other things that there can be no future cause of an event.

2. The psychologist studies only those phenomena which are

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observable and which can be measured. His reliance upon the scientific method requires him to reject *common sense judgments* and *intuitive guesses* (intuition\*) as sources of exact information.

3. The psychologist formulates his hypotheses and theories with caution. He often follows a dictate established by Lloyd Morgan\* in 1894, known as *Morgan's\* canon* (the law of parsimony). This law states, in its basic essentials, that the simplest explanation is the best for interpreting human and animal behavior.

4. The psychologist never evaluates what his subjects do. He does not say that a response is "good" or "bad." The science of psychology, like other sciences, is not given to ethical and moral evaluations of its data.

### AIMS IN PSYCHOLOGY

The aims of the psychologist are threefold. (1) *Understanding and knowledge*. Man has always been interested in knowing about himself and his fellows. Psychology affords a way by which men can acquire this information. (2) *Prediction*. The psychologist, after discovering what a subject does, predicts or foretells (makes a *prognosis\**) what his subject will do in the future. (3) *Control*. When the psychologist can predict what his subject will or can do, then he may be able to bring to bear influences (determiners) which may alter the individual's behavior in the future. A case in point is the social control of delinquency and crime.

### PSYCHOLOGY AND OTHER FIELDS

Psychology is closely related, first, to philosophy\*, the mother of all knowledge. For its own beginnings and for the development of the scientific method, psychology is indebted to philosophy. Psychology is related, second, to physiology\*. Man, as an animal, is studied by the physiologist who tells us much about the relations between man's structure and his capacity for function. The division within psychology which aids in interpreting these interrelationships is known as physiological\* psychology. Psychology is related, third, to the new science of *sociology*. When the psychologist studies the behavior of man in a group he is

studying social\* psychology and is only one step removed from sociology, the study of the behavior of groups. It is easy to see why psychology is frequently classified among the sciences as either a biological or a social science. Broadly conceived it is both.

## TEST QUESTIONS

A. *True-False Statements.* Study each statement and decide as to its truth or falsity.

1. Science is evaluative.
2. A prognostic test foretells success or failure.
3. Introspective methods are used in studies of animal behavior.
4. Human behavior is occasionally accidental and uncaused.
5. A theory has less supporting evidence than a hypothesis.
6. Psychology relies upon the methods of common sense and intuition.
7. Clinical psychologists frequently use the case history method.
8. The co-twin control and the cross-section methods are forms of the genetic approach.
9. All conditions, save one, must be invariable in an experiment.
10. A random sampling means that the subjects have been selected as representative of an entire population.
11. Two aids in a psychological experiment are the statistical and the mechanical.
12. Comparative psychology studies animal behavior in relation to human behavior.
13. "E" designates the experimenter and "S" the subject.
14. The method of correlation discloses the degree of relationship between traits.
15. Psychology, broadly conceived, is both a biological and a social science.
16. Human behavior must occasionally be accounted for in terms of future causes.
17. Monism means that a given phenomenon is accounted for in terms of two factors.
18. Psychology which studies the behavior of the normal adult is called Genetic Psychology.

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B. *Matching Test.* For each item in the second column, select the contributor listed in the first column.

Sigmund Freud	1. Early student of hypnotic phenomena
John Dewey	2. Theory of evolution advanced in 1859
G. S. Hall	3. The Doctrine of Specific Nerve Energies
Empedocles	4. A pluralism to account for mind and matter
Charles Darwin	5. Early student of adolescent behavior
Anton Mesmer	6. Emphasized Functionalism in psychology
Wm. McDougall	7. Doctrine of associationism
Hermann Ebbinghaus	8. Justified use of inductive method in 16th century science
Johannes Müller	9. Father of psychoanalysis
von Helmholtz	10. Early student of memory
E. B. Titchener	11. Father of the study of individual differences
Aristotle	12. Theory of audition
Francis Bacon	13. Men's wants are the keys to their natures
Francis Galton	14. Founder of Behaviorism
John Watson	15. Psychology is the study of the structure of the mind

C. *Completion Statements.* Read the following fifteen incomplete statements and decide on the words that would complete each statement.

1. The belief that objects are controlled by spirits is called the doctrine of
2. The first laboratory for psychological experimentation was opened in the year
3. According to Plato ideas were either or
4. St. Augustine originated the method of in scientific observation.
5. The study of statistics was contributed to psychology by the field of

6. That mind was compartmentalized into a series of entities such as volition, intellect, feeling, is known as the doctrine of
7. The study of psychophysics was advanced by the German physicist
8. The \_\_\_\_\_ psychologist states "The whole is greater than the sum of its parts."
9. A modern therapeutic agent for the treatment of maladjusted personalities is called \_\_\_\_\_
10. The two methods of observation used in the psychological laboratory are called \_\_\_\_\_ and \_\_\_\_\_ observation.
11. The development of the mathematics underlying the normal curve of distribution was achieved by the mathematicians named \_\_\_\_\_ and \_\_\_\_\_
12. According to Aristotle the doctrine of associationism accounted for recall as a consequence of the three factors called \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_
13. No psychological experiment can ever have more than one \_\_\_\_\_ variable.
14. The anatomist who developed the pseudo-science of \_\_\_\_\_ in the nineteenth century was named Gall.
15. The three steps in psychoanalytic treatment are known as \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_

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## CHAPTER TWO

# *The Neural Basis of Behavior*

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### WHY STUDY THE NERVOUS\* SYSTEM?

PSYCHOLOGY includes a study of the nerves\* and their connections with sense\* organs, muscles, and glands\* because modern man wishes to know not only the *why* of his actions, but also the *how* of them. An understanding of the structures of the nervous system, the sense organs, the striated and smooth muscles, and the glands helps us to answer this *how* question. For this reason the psychologist and the physiologist study the nervous system. Their study illustrates clearly the inter-relationships between the two sciences\*, and shows that psychology draws some of its subject matter from physiology\*. Inter-relationship among the fields of knowledge is the rule rather than the exception. How man's activities come to be co-ordinated and integrated is a question that requires a study of the relationship between structure and function.

### GENERAL STRUCTURE OF THE NERVOUS SYSTEM

The human body is composed of tissues which go to make up organs and systems of organs. The two mechanisms by which these tissues, organs, and systems are co-ordinated are the *circulatory* and the *nervous systems*. The former system is the medium for the transportation of foods and waste products. The latter system connects organs of the body with the common co-ordinating centers, the brain\* and the spinal\* cord. By virtue of these

numerous neural connections, the organism is able to respond in an integrated manner to any stimulus\* which is strong enough to excite the sense organs. Inasmuch as the complexity of the nervous system closely parallels the complexity of the responses made by any animal, it is important to see how this system is constructed and how it functions.

The human nervous system is composed of two major divisions.

The first division is known as the *cerebro-spinal\** system which is divided, in turn, into two smaller systems, the *central\** and the *peripheral\**. The peripheral portion is made up of thirty pairs of spinal nerves which transmit sensory or *afferent\** messages to the brain or to the cord from the sense organs located below the neck region. These spinal nerves\* also carry motor or *efferent\** messages from the brain and the cord to the skeletal or *striated\** muscles. They, also, transmit motor impulses to the autonomic\* nervous system for activation of the glands\* and smooth\* muscles of the viscera\*. The fact that spinal nerves consist of both sensory and motor components and that each part is related to a different region in the spinal cord is known as Bell's\* Law (1811). The central division of the cerebro-spinal system consists of three parts. It is made up, first, of twelve pairs of cranial\* nerves which supply neural connections from the sense organs, to the muscles, and the glands located in the head region. The central division is made up, in the second place, of neural tissue, enclosed within the vertebral column (backbone), called the spinal\* cord. Third, the central system includes neural tissue, encased within the skull, called the brain\*.

The second major division of the human nervous system is called the *autonomic\**. This system is mostly motor or efferent\* in function. Certain nerve fibers, arising from the brain\* stem and the spinal\* cord, carry efferent impulses to the autonomic nerve centers, and thence to the smooth\* muscles and glands\* of the vital\* organs (such as the heart, lungs, adrenal glands, stomach walls, spleen) of the body. The autonomic system, thus, is involuntary\* in its action, since we are unaware of its functioning and since we can exert very little control over it. The origins



of the autonomic nerves, reaching out to the smooth muscles and glands of the body, are threefold. The nerves arising from the upper brain stem are known as cranial\* nerves, while those arising from the lower region of the spinal\* cord are called the nerves of the sacral\* division. Those fibers arising from the middle portion of the spinal cord are called thoraco-lumbar\*. These segments make for double innervation\* of the vital\* organs. The nerve fibers arising from the cranial-sacral segments often work together and are antagonistic in function to those arising from the thoraco-lumbar region of the spinal cord. The reactions of these organs of the viscera\* at any one time depend upon which set of nerves is functionally dominant. In general, reactions arising from the thoraco-lumbar segment (often designated as the sympathetic\* nervous system) reduce the normally smooth functioning of the visceral organs, whereas the cranial-sacral reactions (often designated as the parasympathetic\* nervous system), working together, make for continued orderly functioning within the digestive, circulatory, respiratory, and glandular systems. The role of the autonomic\* nervous system is discussed further in Chapter 8 which deals with man's affective life.

## UNITS OF STRUCTURE AND FUNCTION

All tissue of the human organism is basically protoplasmic. The nervous system possesses properties in common with this basic substance of all living matter. Among these are the properties of *irritability*, *conductivity*, *contractility*, *modifiability*, *integration*, and *metabolism*. The property of irritability, or excitability, of sense organs and nerve fibers makes for sensitivity to particular physical energies, and so for stimulation. The property of conductivity makes possible the transportation of a physico-chemical change (the *nerve impulse*) from one part of the system to another. The property of modifiability makes possible the acquisition of new responses (by the process of learning). The fact that protoplasm shows physico-chemical organization serves to indicate the structural basis for the co-ordination or integration\* of traits of personality\*. The property of contractility is evident in the contractile capacity of smooth\* and striated\*

muscles innervated by motor or efferent\* nerves\*. With the conduction of the motor nerve excitation to the muscle, muscular

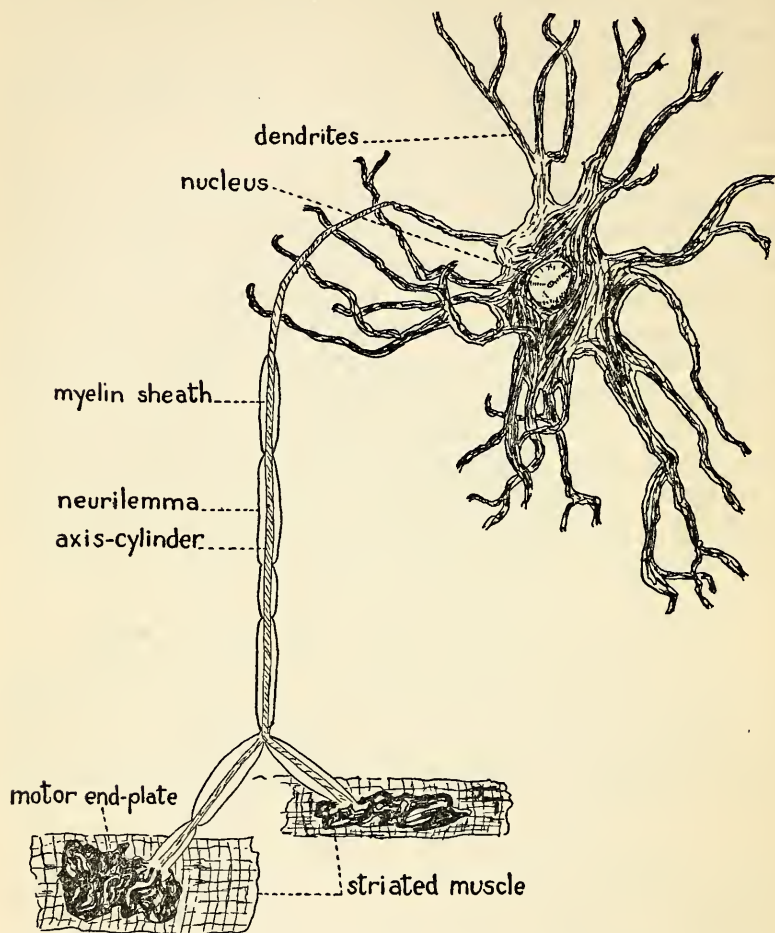


Fig. 1. Diagram of a single neurone showing the dendrites, cell body and its nucleus, the single axone and its terminations within muscle tissue. (Reprinted with permission of the Odyssey Press from Vaughan, *General Psychology*, 1939, p. 134.)

contraction ensues. Just as protoplasm of the one-celled amoeba requires food materials, so, too, do nerve and muscle tissues.

Experiments indicate that these tissues generate heat and electricity in very small amounts, give off carbon dioxide, and require oxygen and other chemicals in order to function normally. These exchanges between the tissues and the physiological environment (blood and lymph) are known as *metabolic processes*.

The structural unit of the nervous system is the neurone\*. Neurones are grouped together in bundles to form what is popularly known as "nerves"\*, or, more correctly, *nerve tracts*. Many thousands of single nerve fibers are included in a tract. These bundles either *ascend* to higher centers by way of their

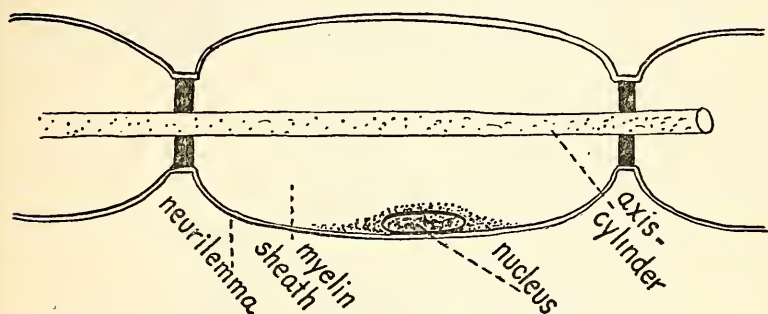


Fig. 2. Greatly magnified diagram of the axone cylinder and its sheaths. (Reprinted with permission of the Odyssey Press from Vaughan, *General Psychology*, 1939, p. 135.)

positions in the spinal\* cord and brain\* stem, or they *descend* from higher centers to lower ones by means of the brain stem and spinal cord. Each neurone is composed of a cell-body\*, an axone\*, and dendrites\*. The cell body, with its *nucleus*, supplies food for the neurone. The axone, a long fibrous extension from the cell body ending in an endbrush\* or brushy formation in close proximity to dendrites of another cell-body, may be branched or unbranched. The dendrites, short and numerous brush-like processes, are in close relationship to either sensitive receptor\* cells within sense organs or to other axones. The dendrites are bare, while the axone\* cylinder (nerve\* fiber core) usually possesses two *sheaths* or coverings. About the axone core is the myelin\* or fatty sheath which is white in appearance. Because of this

whitish appearance certain portions of the spinal\* cord and brain\*, made up of axones so coated, are said to compose the white\* matter. Around the myelin is the neurilemma\* or *Sheath of Schwann*. This coat is absent from the myelinated axones of the central nervous system. The neurilemma is believed essential for the regeneration of nerve fibers following injury or disease. The portions of the neurone without coverings, the cell body and

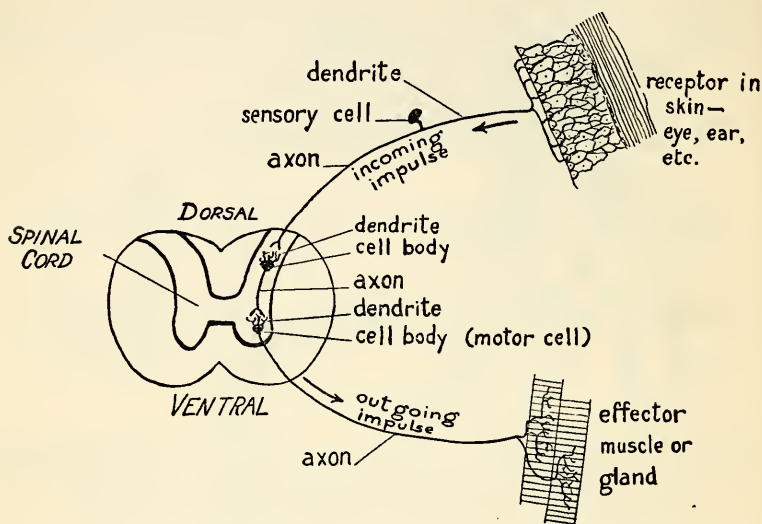


Fig. 3. Oversimplified and enlarged diagram of the sensorimotor arc as the unit of function in the nervous system. (Reprinted with permission of the Odyssey Press from Vaughan, *General Psychology*, 1939, p. 138.)

the dendrites, are gray in appearance. They make up the gray\* matter of the brain and the spinal cord. This fact tells us why people often speak of "the gray matter" when discussing, for example, the functions of the cerebral cortex.

The unit of function within the nervous system consists of at least one sensory and one motor neurone\* in functional relation. No single neurone can alone perform any service in the mediation of responses. This two-neurone chain is known as the sensorimotor\* arc or as the reflex\* arc. Fig. 3 is diagrammatic. Most

frequently many neurones are involved in making responses to stimulation.

The junction between the endbrush\* of one axone\* and the dendrites\* of the second neurone is known as the synapse\*. The nerve impulse, defined as a propagated disturbance, passes from the dendrites, by way of the cell body, to the axone, thence over the synapse to the dendrites of the second neurone. This one-way conduction of the neural excitation is designated as the principle of polarity\* of neural transmission. Nerve messages flow in the forward direction across the synapses from one neurone to the next. Fig. 4 is illustrative. Only if a single, isolated neurone is stimulated electrically will the excitation flow in the other direction. This is known as an antidromic\* conduction.

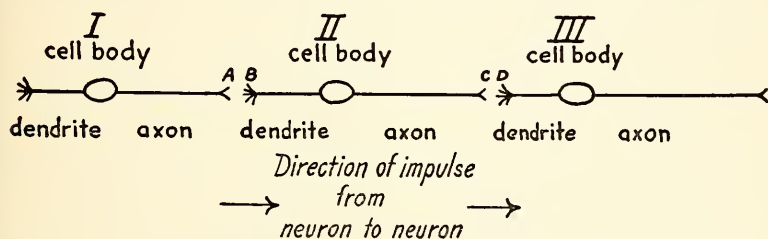


Fig. 4. Schematic diagram of the relationships between neurones. Note the location of the synapse and the direction of passage of the disturbance. (Reprinted with permission of the Odyssey Press from Vaughan, *General Psychology*, 1939, p. 136.)

At one time it was believed that the synapse exhibited greater *resistance* to the passage of the nerve impulse than did other regions of the functional unit. Accordingly, learning was considered by the physiologist to consist in reducing this resistance. This resistance\* hypothesis, although no longer generally accepted in its original form, has given impetus to a detailed analysis of synaptic transmission which is still in progress.

## THE NERVE EXCITATION

Numerous studies have been made to determine the nature of the nerve impulse. Although much information has been accu-



mulated no completely satisfactory explanation is available. The impulse is known to be an energy change initiated by sensory stimuli impinging upon sensitive receptor\* cells within sense\* organs. The rate of transmission of this propagated tendency to excite is said to be between 100 and 120 meters per second in certain mammalian nerves\*. Passage of the nerve impulse along the nerve is accompanied by electrical disturbances which can be detected by appropriate instruments, then amplified, and recorded. The sensitive galvanometer\* is used to measure these minute electrical changes during neural conduction. These action\* currents, as they are called, are assumed by some to be initiated by chemical changes which, in turn, initiate the electrical changes in potential. This theory holds that there is a continuous interaction between the chemical and electrical activities of the stimulated nerve fiber.

One important principle of neural function is the *Law of All or Nothing Action* formulated by the English physiologists, Lucas and Adrian (1917). They found that an increase in the strength of the stimulus\* applied to the isolated nerve did not increase the size of the action\* currents. This discovery means that if the stimulus is strong enough to excite a single nerve the response of this nerve is *maximal*, regardless of the strength of the stimulus. This principle is the All\* or None Law.

To account for the fact that the strengths of stimuli are usually related to the intensities of their elicited responses, physiologists have proposed two theories. First, the strength or magnitude of the response may depend upon an increase in the number of sensory fibers stimulated. The larger the area of stimulus application the more sense nerve fibers stimulated. This is known as the *multiple\* fiber theory*. Second, the *frequency theory* assumes that the stronger the stimulus the more often, during stimulation, the nerve sends impulses to the brain. A stronger stimulus would thus evoke a quicker succession of nerve impulses than would a weaker, though still physically adequate stimulus. These two theories are used to account for the correspondence between the strengths of stimuli and their correlated intensities of sensation as well as for the magnitudes of muscular responses. It is con-



cluded, therefore, that the nerve\* fiber, either sensory or motor in function, is a conductor and that all nerve impulses are similar to one another. They induce different effects because of different points of termination in higher centers or because of their connections with different muscles and glands\*.

### THE CONCEPT OF NEURAL LEVELS

Surgical intervention in the normal functioning of the nervous\* system of animals has shown that specific levels of the central\* nervous system possess specific functions. The nerve pathways from sense\* organs to muscles and glands\* at the level of the spinal\* cord constitute the *first* or *spinal level*. Reactions involving this level are known as *spinal reflexes\**. Involuntary, unlearned withdrawal of the finger from a candle flame is an illustration of spinal reflex action. The nerve pathways between the sense organs and the muscles which lead through the medulla and the brain stem regions are the structural counterparts of reactions of the *second* or *brain\* stem level*. Blinking of the eye in response to a foreign particle is an illustration of the reflex\* arc at this level. The brain stem, in addition, acts to integrate incoming sensory impulses from all parts of the body. Thus, in lower animals, a fair degree of adjustment to the environment is still possible after the surgical separation of the third from the two lower levels. Such *reflex adjustments*, however, are relatively fixed (stereotyped) and unchanging among lower animals, whose cerebral hemispheres are relatively undeveloped. The nerve pathways extending from the sense\* organs to the muscles by way of the cortex\* of the cerebrum\* constitute the *third* or *cortical level*. Response to a burn on the finger by applying an ointment is an illustration of voluntary\* action at this level.

These three levels of reaction, based upon the experimental investigations of the English physiologist, Sir Charles Sherrington\*, are similar in that they utilize nerve pathways extending from the receptor\* mechanisms within the sense\* organs to the muscles and glands\*. They differ only in the connections made and in the complexity of the functions which they mediate. Reflex reactions—relatively simple, unlearned, involuntary\* reactions to

stimuli—are mediated by the first and second levels, while activity of a more complex nature (learning, remembering, planning) is mediated by the third level.

### STRUCTURES OF THE CENTRAL\* NERVOUS SYSTEM

The brain\*, the spinal\* cord, and the cranial\* nerves make up the central division of the nervous system. The brain is divided

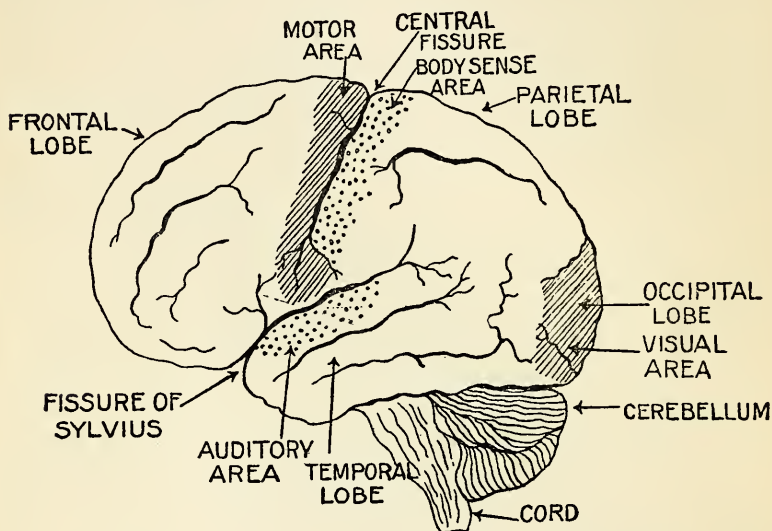


Fig. 5. Lateral view of the left hemisphere showing the sensory and motor areas as well as the larger fissures. (Reprinted with permission of the Macmillan Company from Gates, *Elementary Psychology*, 1929, p. 94.)

(incompletely) into two *hemispheres* connected with one another by bands of nerve fibers called the corpus callosum\*. The median\* fissure is the dividing line between the two spheres. The left hemisphere is dominant in numerous activities performed by right-handed individuals, while the right hemisphere plays a dominant role in the control of human behavior among left-handed persons.

The outermost portion of each hemisphere is composed of from

five to six layers of cells (three millimeters in total thickness) known as the *gray matter* or as the cerebral cortex. The cerebrum\* is also composed of bands of axone tracts or *white\* matter*. This white and gray matter together make up the cerebrum. The cerebrum rests upon the brain\* stem with which it is in direct structural connection. The brain stem is composed of way stations through which ascending sensory and descending motor nerve impulses pass on their ways to the cortex or to the muscles and glands. These stations in the brain stem are called in order from the cerebrum downward, the thalamus\*, the pons\*, the cerebellum, and the medulla. Table 1 indicates these structural divisions of the brain stem. The medulla connects directly with the gray and white matter of the spinal cord located within the backbone. In addition to the reflex functions of the brain stem, these structures also play other roles. The cerebellum is a co-ordinating and balancing organ as shown by injuries to it which have caused disturbances in gait and in fine muscular co-ordinations. The thalamus acts as a co-ordinator of incoming sensory nerve impulses from all parts and as an essential organ in the mediation of emotional responses. Nerve excitations from the sensory areas of the body pass to the spinal cord, thence upward via the white matter of the cord through the medulla, pons, and thalamus, to terminate in the *sensory areas* of the *cerebral cortex*. Descending impulses, arising from within the motor\* areas of the cerebrum, pass down by way of the thalamus, pons, medulla (where many of them *decussate\** or cross over from right to left or vice versa), and cord to the skeletal muscles as well as to the smooth\* muscles and glands innervated\* by the neurones\* of the autonomic\* system.

The cortex, thus, becomes the primary co-ordinating center of human behavior. The cerebral cortex is essential for the higher mental processes of thinking, perceiving, learning, remembering, and reasoning. Without the cortex, then, man becomes essentially a reflex organism—alive, but characterized by unconscious, inflexible, automatic reactions to any adequate physical stimulus\*. Such a person would be at the mercy of his environment.

The main parts of the cerebral hemispheres are the cortex\* and the *axone fiber tracts* (white\* matter). Sensory impulses

TABLE 1

# CONDENSED OUTLINE OF THE DIVISIONS OF THE HUMAN NERVOUS SYSTEM

Arrow 1 indicates the anatomical and functional relationships between the spinal cord and the spinal nerves. Arrow 2 shows the relationship between the spinal nerves and the sympathetic system. Arrow 3 indicates the relationship between the cranial nerves and the cranial-sacral segment of the autonomic division.

## I. Cerebro-spinal Nervous System

### 1. Central division

#### A. Brain

Cerebrum { Gray matter  
White matter

Brain stem { Thalamus and hypothalamus  
Pons and cerebellum  
Medulla

#### B. Cranial nerves—12 pairs

Sensory components

Motor components to  
muscles of neck, head

3 ← Motor connections with  
parasympathetic system

#### C. Spinal Cord

### 2. Peripheral division

#### A. Spinal nerves—30 pairs

Sensory components

Motor components to  
skeletal muscles

Motor connections with  
sympathetic system

## II. Autonomic Nervous System

### 1. Cranial-sacral division

(Parasympathetic system)

### 2. Thoraco-lumbar division

(Sympathetic system)

from the periphery (body surfaces) and from the internal organs are relayed by way of the thalamus\* to these cellular layers of the cortex. The messages are transmitted by connecting or *associative*

neurones to motor\* areas of the cerebrum\*. Efferent\* impulses are then initiated and transmitted to the muscles and glands of the body, thereby mediating man's adjustments to the numerous stimulating complexes which impinge upon his sense\* organs. Man's past training also contributes to these adjustments by virtue of his ability to remember what he has learned. Incoming and outgoing nerve excitations are carried by neurones making up the *projection systems* of the cerebrum. Interconnections at the cortical level are made by the aforementioned *associative* neurone systems. Incoming sensory messages keep us informed of what is going on. The associative nerve fibers make for the integration of the present message with previous experiences for which after-effects in the form of *memory\* traces* are assumed to exist. The descending (motor) excitations to the muscles and glands by way of the projection tracts ensure the carrying out of purposeful, adaptive responses. Co-ordinated function of the two cerebral hemispheres is brought about by means of *commissural* (bridge-like) bands of fibers which connect the two hemispheres.

Careful study of the cells of the cerebral cortex indicates regional differences in size, shape, and arrangements of the gray\* matter. These differences from area to area are correlated with the effects on behavior which result when tissue is surgically removed from different regions. The various areas of the cortex thus possess specialized functions. The occipital\* lobe (Fig. 5) functions in vision. The temporal\* lobe of each hemisphere mediates responses to sounds. The parietal lobe receives sensory impulses from the body areas and from the muscles. The frontal\* lobe transmits motor impulses to the muscles, glands\*, and viscera\*. The senses of taste and smell are mediated by cortical areas located on the mesial or under surface of the hemispheres. In addition, these various lobes possess *associative* functions. The cerebral cortex of both hemispheres is made up, in summary, of *sensory\**, *motor\**, and *associative areas*. The associative fibers connect the sensory\* with the motor areas and make up a large portion of the cerebrum. Fig. 5 shows the sensory and motor areas of the cerebral cortex. Fig. 6 shows the associative nerve tracts.



The functions of selected areas may be illustrated by reference to the act of reading aloud a short story. Perception\* of visual stimuli\* is mediated by the optic (a cranial\*) nerve and the occipital\* cortex. Nerve messages pass by associative neurones\* to the motor speech areas of the frontal\* lobes. Motor impulses,

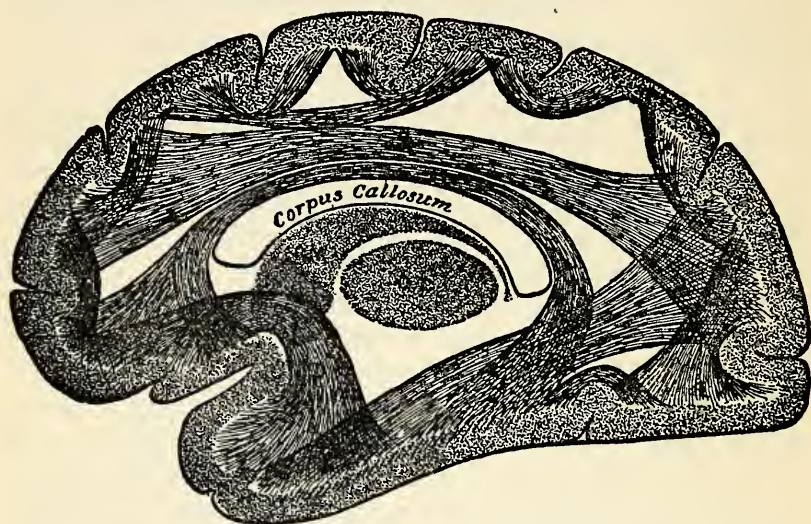


Fig. 6. Associative bundles of neurones connecting the lobes of the brain. The corpus callosum connects the two hemispheres. (Reprinted with permission of the Macmillan Company from Gates, *Elementary Psychology*, 1929, p. 95.)

then, are initiated and relayed to the vocal musculature, for oral expression of that which already has been seen and understood.

### GENERAL PRINCIPLES OF NEURAL ACTION

The following principles will aid in understanding how the nervous\* system co-ordinates or integrates human behavior.

1. *The principle of diffusion\**. The fact that all organs of the body are connected by nerves\* with the central\* nervous system means that, other factors being satisfactory, excitations initiated in every sensitive cell of each sense\* organ may be transmitted to



any or all of the muscular and glandular response mechanisms. Although this rarely happens, it is possible. A nerve impulse may, consequently, be said to be capable of diffuse action. Sensory impulses initiated early in the life of an infant, for example, show considerable diffusion, as judged by the generalized and diffused responses to specific stimuli\* applied to a sense organ. Any sensory stimulus may become, by virtue of learning, associated with any response mechanism. Diffusion makes this possible.

2. *The principle of convergence\**. Sensory impulses from several sense organs may converge upon one effector mechanism. This is illustrated when stimuli from different sense modalities are presented at the same time. They elicit a response, although no response is apparent when one stimulus is presented alone. Our reactions may, therefore, be intensified by the convergence of sensory impulses upon a single effector mechanism.

3. *The principle of summation\**. We occasionally shout to a person who does not understand English very well. We are trying to "facilitate" his understanding of what we are saying. When two or more stimuli, all influencing the same receptor mechanisms, are given at once, a more prompt and vigorous reaction often occurs. This is *facilitation* or *summation* by way of sensory excitations adding together to evoke a more certain response. Indeed, two stimuli, alone producing no response, if presented either simultaneously or in immediate succession to a sense organ may summate and elicit a response.

4. *The principle of inhibition\**. One may prevent a sneeze by applying pressure upon the upper lip. This prevention of a tendency to respond is known as inhibition. It is an active rather than a passive process, inasmuch as it depends upon stimulation for its induction. The mechanisms by which inhibition is made possible are not yet completely understood.

5. *The principle of reciprocal\* innervation*. The muscles of the body work in antagonistic pairs. One group of skeletal or striated\* muscles contracts in raising the arm and another group is relaxed at the same time. The contraction of the second group is in-

hibited. A high degree of co-ordination in behavior is assured by virtue of this dual innervation\* of antagonistic muscles of the body.

6. *The principle of integration\**. Discussion of the parts of the nervous\* system too often implies that each division functions as a separate unit. Isolation is not the rule. Effects in one part influence the reactions of every other part. All subordinate divisions and their respective functions are welded together by means of convergence, diffusion, summation, inhibition, and reciprocal innervation. The various parts and their functions are so unified that such complex activities as walking and talking are the results of integrated action of the whole organism. Integration means, therefore, co-ordination. The organism acts as a unit.

### THE PROBLEM OF CEREBRAL LOCALIZATION\*

The fact that the cerebral cortex\* is divided into sensory\* and motor\* areas led some to assume that tiny parts of each specialized area were related to particular sensory cells or muscle fibers. Destruction of any one of these small cortical\* points would destroy the function of that point. Others, from a slightly different angle, concluded that man's capacities to reason, to remember, to judge, and to think were pigeon-holed in particular cerebral regions. Destruction of any one of these regions would destroy the ability to perform in tasks requiring the function of the injured area. Accordingly, the human brain was once thought to be divided into a series of functional compartments each mediating its own function without co-ordination with the others. This view was carried to an extreme by Gall and Spurzheim who held that man's likes, dislikes, and capacities could be detected simply by mapping the so-called protuberances of the skull.

Within the past fifteen years Lashley\* (1929) and other investigators have refused to accept this theory of *specific localization\** within the cortex. Although the existence of motor and sensory areas is granted, Lashley holds that their functions are much less specific than was once assumed. He maintains that a degree of cerebral equipotentiality\* (functional equivalence)

within cortical regions is characteristic of brain action. Thus, the visual areas had to be removed in their entirety before Lashley observed any disturbance in behavior dependent upon the function of the occipital\* areas (1935). Destruction of equal amounts of brain tissue in different areas caused similar disturbances in the retention of previously learned maze habits. He concluded that capacity to remember could not be pigeon-holed in a particular region of the cerebral cortex. The evidence for these conclusions comes from Lashley's studies of the behavior of operated animals trained to run mazes and to make discriminations between visual patterns. These findings are in agreement with the principle of integrated action of the central nervous system.

### ELECTROENCEPHALOGRAMS\*—"BRAIN WAVES"

Just as the sensory and motor nerves as well as muscle fibers generate electricity, so, too, does the brain-cortex. The waves of electrical potential coming from the cortical tissues of man or other animals are recorded by a series of delicate instruments, chief of which is the cathode ray oscillograph. The technique includes the amplification of the tiny waves of electrical activity, so that they may be recorded permanently and then measured. Fig. 7 illustrates schematically the arrangements needed for the recording of brain waves from the head of the human subject.

Although brain waves have been studied since 1875, Hans Berger\* (1929) was among the first to analyze them in a systematic way. The findings reported by the physiologists who study the electrical activity of neural tissue (electro-physiologists) have indicated that the nervous system is not a "silent system" in the absence of sensory stimulation. Indeed, three types of waves, differing in their frequencies, have been studied in some detail. Berger designated the first two as the alpha\* and beta\* waves. The beta waves are faster than the alpha waves and they persist, unlike the alpha, during and after the presentation of a light stimulus. The third type, designated as delta\* waves, are very slow as shown by frequencies ranging from three to six per second. They have been studied in detail by Hoagland, Jasper,

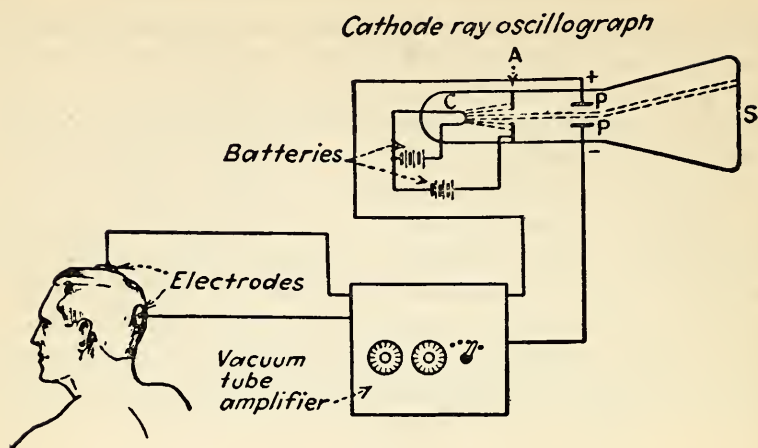


Fig. 7. Diagram of the experimental arrangements used in recording brain waves. The electrical potentials of the brain-cortex give rise to electrical currents which are picked up by the electrodes. These currents are then amplified many times. They then deflect the electrons emitted by the cathode ray (C) at plates P in such ways that the fluorescent screen (S) registers the brain-wave forms. A camera is often used to photograph these changes on the screen. When recorded the brain-wave records are called *electroencephalograms*. The instrument pictured above is called the cathode ray oscillograph. (Reprinted with permission of the McGraw-Hill Company from Crafts, Schneirla, Robinson and Gilbert, *Recent Experiments in Psychology*, 1938, p. 193.)

Gibbs, and others. These facts indicate that instead of initiating electrical activity in a "silent inactive system," as was once assumed, incoming excitations from receptor\* cells initiate a change in the electrical activity of the brain\*.

Several studies of value to the medical profession have been made by means of this technique. The brain waves of normal\* and insane\* people have been compared. In cases of organic\* psychotic\* conditions, the brain waves differ greatly from those of normal people. In cases of functional\* psychotic conditions, few differences from the waves of normal subjects have as yet

been discovered. The most notable changes in the pattern of brain waves occur in the epileptic patient just prior to and during the major seizure or "fit." The brain wave method has also been found useful in the location of brain tumors. These and many other findings suggest that the brain wave technique may be expected to lead to more information concerning brain function. Whatever the final significance of these and future findings, one fact is today quite clear. The brain wave, the electroencephalogram, can never be said to mediate the transmission of thought in space, even if the hypothesis of telepathy should ever be conclusively established.

### TEST QUESTIONS

A. *True-False Statements.* Study each statement and decide as to its truth or falsity.

1. The occipital lobes function in taste and smell experiences.
2. The organism acts as a unit.
3. The corpus callosum connects the two cerebral hemispheres.
4. Each cerebral lobe has projection, associative, and commissural nerve tracts.
5. All axones have the neurilemma sheath.
6. Any sensory stimulus may become linked with any effector mechanism.
7. The cerebral cortex is composed of sensory, motor, and associative areas.
8. Summation of stimuli effects also involves the principle of inhibition.
9. Lashley believes that the brain is composed of discrete sensory and motor points.
10. The cranial-sacral division of the autonomic nervous system is antagonistic in function to that of the thoraco-lumbar segment.
11. Sensitivity to stimuli is related to tissue irritability.
12. Equipotentiality of function is a theory supported by recent findings from animal studies.
13. The myelin sheath gives the whitish appearance to the axones.
14. The stronger the physical stimulus the greater the magnitude of the nerve excitation.



15. Voluntary action is mediated by the neurones of the spinal level.
16. The cortex in the absence of stimulation is in a state of complete inactivity.
17. The structure of the nervous system is studied because it helps the psychologist account for co-ordinated action.
18. The peripheral division of the cerebro-spinal system consists of only twelve pairs of nerves.
19. The nerve impulse or excitation is defined as a propagated tendency to excite.
20. Some nerve tracts within the spinal cord ascend, while others descend.
21. A two neurone chain is called not only the unit of function but also the sensorimotor arc.
22. The galvanometer is used to study the frequency and magnitude of nerve action currents.
23. The multiple fiber theory is one explanation offered to account for the correlation between strength of the stimulus and the magnitude of the muscular response.
24. Reflexes are simple, unlearned, relatively invariable reactions to stimuli.
25. The thalamus is a co-ordinating structure as well as a way-station.
26. Motor tracts arising from the frontal motor areas of the cortex usually decussate at the level of the thalamus.
27. The temporal lobe functions in audition.
28. Man is able to bend his arm. This involves the principle of reciprocal innervation.
29. The cathode ray oscillograph is used in the study of brain waves.
30. Brain waves cannot act as transmitters of thought "waves" should they ever be found to exist.

B. *Completion Statements.* Read the incomplete statements and decide on the words that would complete each statement.

1. The two major divisions of the nervous system are the  
and the  
systems.
2. The thirty pairs of spinal nerves contain both  
and  
components.



3. Another word for a sensory nerve is  
nerve.
4. The two co-ordinating systems of the body are the  
and the  
systems.
5. The middle segment of the autonomic system arises from the  
division of the  
cord.
6. Polarity means that the nerve excitation
7. According to Lucas and Adrian a single nerve when stimulated  
responds or not
8. The structural unit of the entire nervous system is the
9. The functional unit of the entire nervous system is the
10. The gray matter of the spinal cord and the cortex is always com-  
posed of and their
11. The junction between two neurones is called the
12. Electrical phenomena which accompany nerve impulses are  
called
13. Responses by way of the first neurological level are termed
14. The fissure divides the brain incom-  
pletely into two
15. The bark of the cerebrum is called the  
and is composed of layers of
16. The motor areas of the cortex are lo-  
cated in the lobes of the two
17. The "balance organ" of the nervous system is the
18. The cerebral axone bundles are called  
, and  
tracts.

19. The fact that spinal nerves possess both motor and components is called Law.
20. Smooth are supplied with nerves by the nervous system.  
or skeletal muscle fibers are less sluggish in reaction than are the smooth muscles.
21. The energy for nerve transmission and for muscular response is supplied primarily by the man eats.
22. The unit of neural structure is composed of three parts called the , the , and the .
23. cells are the sensitive portions of sense organs.
24. The hypothesis assumes that the synapse transmits an excitation less readily than does the axone cylinder.
25. The autonomic nervous system is primarily in function.
26. Three types of brain waves, called , and , have been distinguished on the basis of their different .
27. The sheath aids in the regeneration of injured nerve fibers.

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## CHAPTER THREE

### *Sensation*

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#### INTRODUCTION

WHAT WE MAY GROUP as the knowing processes are all directly dependent for their materials upon the sense\* organs. A man who has been blind from birth has no notion of what a color might be. We ordinarily assume there are series of stimuli\* or forms of energy in the universe, that these cause changes in the sense organs, and that sensations or sense qualities are produced by the action of the energy that we call the stimulus upon the sense organs. We are inclined to think that the quality we perceive actually exists in the world outside, that objects are red or yellow as we see them. The physicist, however, insists that the process which stimulates the eye is merely a series of vibrations of different rates and that the physical stimuli differ only in the rates. Red is a relatively slow vibration, yellow a slightly faster vibration. Since all light travels at the same rate a slower vibration means a longer wave, a faster vibration a shorter wave. It is only as the various kinds of physical stimuli affect a sense organ and then the brain\* that we become conscious. We may emphasize that the consciousness\* is not of the vibrations as such, but of the results of the stimulation of the sense organ and the brain. Yellow is neither in the light vibration, nor for that matter in the sense organ, nor even in the brain. Only the stimulation of the brain cortex\* by the light produces the sensation\*.

*Metaphysics of Stimulus\* and Sense Qualities.* Philosophers have long speculated about the way by which the physical stimulus can be thought to produce the conscious sensation, but

still without agreement. Some have denied the existence of consciousness, some have denied the existence of the external world, some have said that both are one entity with different aspects. Some assert that stimulus is a direct cause of the quality of consciousness, others assert that the two go together but one does not cause the other. While these theories have affected the thinking of certain schools of psychology\*, we need do no more here than point out the differences. Psychology can proceed with the assumption that there is a stimulus\*, that the stimulus induces physical and chemical changes in the sense\* organ, that these give rise to the nerve\* impulse which is transmitted to the cortex, and that a sensation results.

*Sensory Tissue Determines the Qualities of Sensation.* We find that the quality of the sensation depends upon the sense organ stimulated rather than upon the character of the stimulus\*. There are as many sense qualities, and only as many, as there are different kinds of sensory tissue. It is generally true that a different kind of physical energy stimulates each sense organ; but there are exceptions, and when the same kind of physical energy stimulates more than one organ, the quality of sensation varies with the sense organ rather than with the stimulus. Thus, long waves of light stimulate the eye, and they also stimulate the organs of warmth in the skin. When they stimulate the eye we see red; when they stimulate the skin we feel warmth. These facts and others led Johannes Müller\* to formulate the law that it is the character of the sense organ that determines the quality of sensation. He called this principle the *doctrine of Specific\* Energies*.

*All the Data of Knowledge are Derived from the Senses.* The study of the origin of sense qualities is important, for not merely all sensing and perceiving are dependent upon the senses, but all remembering, imagining, and thinking are ways of modifying or organizing the contributions of the senses. Some schools of psychology emphasize the processes of organization more than others, but all agree that there are no true qualities of experience that do not come originally from the senses. Old sense qualities are recalled in memory\* and manipulated in imagination\* and in thinking, but these processes do not create any new kinds of

sensation. If you attempt to image what quality might correspond to a new sense developed to receive radio waves directly, you cannot create an entirely new quality. You can only think of something like a color or a sound and then think that the new quality must be some modification of that.

*The Classification of Sensations.* Traditionally, since Aristotle at least, it has been asserted that man has five senses: sight, hearing, touch, taste, and smell. Modern science\* has discovered many other senses. Sensations from the muscles constitute the kinaesthetic\* sense. There are sensations of hunger and thirst. Masses of sensation, still unanalyzed, arising from the visceral organs, indicate the state of health or disease. We might also refer to the organs in the vestibule of the ear that are excited by changes in the position of the head. These excitations arouse reflex changes in the posture of the body and limbs, but probably do not arouse definite sensations. Special forms of energy, light waves, stimulate the eye; sound waves in the air excite the ear. The skin has four different sense organs. Two of these, organs for pressure and pain, respond to slight and to strong mechanical stimulation; two others, organs for warmth and cold, respond to high and to low degrees of temperature.

All these sense qualities might be named by reference either to the sense\* organ or to the physical stimulus\*. Sight and hearing raise no question. The organ and the stimulus go together. We group the skin senses as cutaneous\*, and then divide them again into mechanical and temperature senses. The senses of taste and smell are grouped according to the organs used. Each is stimulated by chemical substances, most of them different for the two senses. When the same substance stimulates both, each quality is named from the organ it stimulates.

## VISION

*Visual Sensations.* The eye, which supplies the greatest number of sense qualities, is probably the most important source of knowledge. The stimuli for vision are light waves. The eye is sensitive to a narrow band of light vibrations ranging in length from approximately 760 millionths to 400 millionths of a millimeter in length. The long waves of light excite red from 760



to about 660 millionths of a millimeter. Wave length 610 gives us a good orange, 580 a good yellow, 480 a blue, 430 a violet. These shade gradually over into each other, so that there is no complete agreement even between the most competent observers as to the exact boundaries. When two colors are mixed, a color between them in the spectrum will be produced. Colors may be mixed by combining pure light waves with a spectroscope or filters or, more readily, by making a disk that is partly of one color and partly of the other and rotating the disk rapidly.

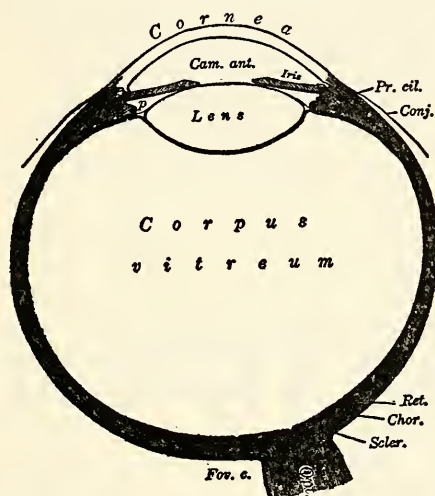


Fig. 8. Horizontal section of the eye. *Scler.*, sclerotic coat; *Chor.*, choroid coat; *Ret.*, retina; *Opt.*, beginning of the optic nerve; *Fov. c.*, fovea centralis; *Pr. cil.*, ciliary muscle or ciliary process; *Conj.*, conjunctiva; *Cam. ant.*, anterior chamber, filled with aqueous humor. (Reprinted with permission of the Macmillan Company from Pillsbury, *Fundamentals of Psychology*, 1934, p. 103.)

*The Structure of the Eye.* To understand vision we must know something of the eye. The eye is roughly similar in function to a camera in that it must focus an image of objects upon a sensitive surface that transmits the effects to the brain. It is made up of three main coats. The outer or *sclerotic coat* is an approximate

sphere of connective tissue, opaque in the posterior part, but with a slightly bulging transparent portion in front, the cornea\*. Within the sclerotic coat is the *choroid\* coat*, composed mainly of blood vessels. The choroid coat in the anterior part of the eye is not attached to the sclerotic coat, but stretches across the cavity to constitute the iris, that gives color to the eye. The pupil is a hole in the iris that permits light to pass through. Inside the choroid coat is the *retina\**, the sensitive coat of modified nerve tissue that receives the light waves and is changed by it chemically to produce nerve impulses.

*The Formation of the Image.* The first function of the eye is to project an image of the outside object upon the retina\*. This result is effected by the two lenses, i. e., the cornea\* and the crystalline lens, a lens just back of the iris, attached to the choroid coat by ligaments. The simplest way to state the functions of the lenses is to say that the light that falls upon the surface of the cornea is bent so that all rays pass through a single point, known as the nodal point, that lies in the average eye about 7 mm. in back of the surface of the cornea and 15 mm. in front of the retina. The effect would be duplicated by a pin hole camera, with a pin hole through which the light comes at a distance of 15 mm. from the back surface. An inverted image is produced on the retina.

*The Retina of the Eye.* The retina\* is embryologically a part of the brain\* that grew out to the surface of the head in the process of development. It is composed of three layers of neurones\*. The layer of rods and cones\* that is first affected by the light lies nearest the choroid coat and farthest of the three coats from the light. The rods and cones that compose this layer differ from each other in shape and in function. The rods are long and slender, .002-.004 mm. in diameter and .040-.060 mm. long. They see only black, white and gray, what the psychologist calls brightness\*. The cones are shorter and thicker, .004-.006 mm. wide and .020-.040 mm. long, except in the fovea\*, where they have about the same dimensions as the rods. The cones see colors as well as brightness. The fovea is a small depression near the center of the retina. About it and over it is a yellow pigment, the yellow spot\* (*macula\* lutea*). The fovea is the point of clearest

vision. One turns it toward any object that one desires to see clearly. Only cones are found in the fovea. From the rods and cones the nerve impulses pass first to the bipolar cells of a second

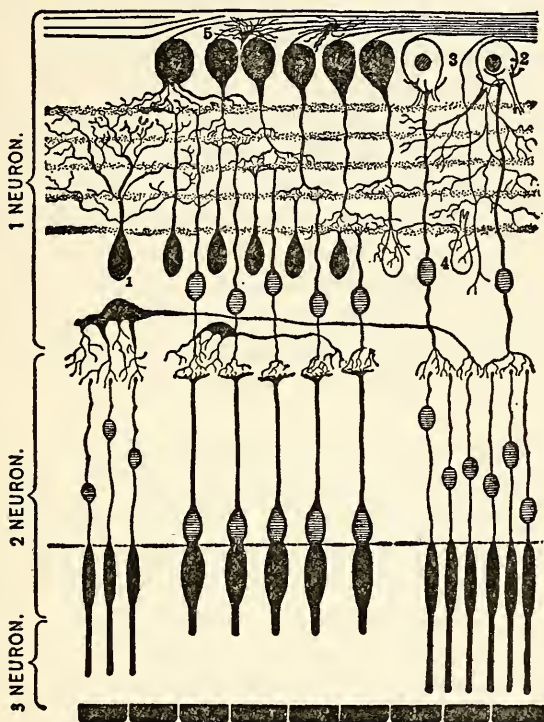


Fig. 9. Section of the retina (schematic). The rods and cones are at the bottom of the figure; at the top are the large ganglion cells and the axones that combine to form the optic nerve. Light passes through from the top to the rods and cones at the bottom. (Reprinted with permission of the Macmillan Company from Pillsbury, *Fundamentals of Psychology*, 1934, p. 108.)

layer, and then to the large ganglion\* cells of the third layer. The axones\* of the ganglion cells combine to form the optic nerves, that carry the impulses to the thalamus\* from which the connections are made with the cerebral cortex\* and midbrain.

*The Relations of Rods and Cones\**. The rods are especially sensitive to faint lights, but give less clear images than the cones. The greater sensitiveness is due to the visual\* purple that is found in their outer segment. This pigment is purple after a long period in the dark, and fades to a yellowish white after exposure to light. When purple it is extremely sensitive to faint lights. After one has been an hour in a dark room, the purple has almost completely regenerated. One can then see a light that is only one thousandth of the intensity of the light that can be seen when one has come in from a bright light. The cones alone are sensitive to color differences. The cones discriminate spatial distances more accurately. This may be in part explained from the fact that each cone connects with but one bipolar cell and so may send its image to a single unit in the cortex\*. Several rods on the other hand connect with one bipolar cell. In each eye there are millions, probably more than a hundred million, of these rods and cones.

*Color Theories*. The facts of color vision may be stated in connection with two of the more important theories. Relatively few kinds of organs in the retina give rise to all of the visual experiences. Helmholtz\* held that there are but three primary colors: red, green, and blue or violet. Any two primary colors when stimulated simultaneously give rise by combination to those intermediate between them in the spectrum; red and green give yellow; green and blue, a greenish blue; red and blue, purple. When all three primary colors are excited in the same amount they produce white. Hering\* at about the same time, insisted that there are four primary colors, red, green, yellow and blue, and that the colors are combined in pairs. Each of the pair is produced by an opposite reaction of the same organ. Red is produced when the red-green organ undergoes catabolism\*—when its nourishment is reduced; green is seen when the same organ undergoes anabolism\*—when it is built up. Yellow arises when the yellow-blue organ undergoes catabolism and blue when anabolism occurs. He added a third organ that responds in the same opposed ways to give white and black. It is sensitive to all wave lengths. When red and green are equally strong their effects on



the red-green organ cancel each other, but both stimulate the black-white organ so that we see gray.

*Complementary\* Colors.* As the Hering\* theory brings out most clearly, several peculiar relationships exist between red and green, blue and yellow. The first fact we have mentioned above—when they appear in equal amounts they produce white. From Helmholtz' theory that two colors, red and green, *e.g.*, supplement each other when they combine to produce white, they are called complementary\* colors. Every color has its complement. Apart from the primaries, the complement of any combination is made up of all the other primaries not represented in it. A reddish blue, or purple, finds a complement, *e.g.*, in a greenish-yellow. These pairs show other unique relationships. If one looks a few seconds at a single color, and then at a gray surface, one will see its complement after a second or two. Green is followed by red; blue by yellow. Helmholtz\* believed that looking at green fatigues the green 'organ,' so that later when one looks at white or gray, only the other two components, red and blue, are stimulated. Hering's theory assumes that stimulation of the red-green organ by red reduces the anabolism\* below the balance so that when the stimulation is removed the organ returns to equilibrium or beyond, and thus gives rise to a green. The after-image\* is a positive process, not a subtraction effect as with Helmholtz.

*Contrast\* Colors.* When a color is seen there is also seen in the area surrounding it the complement of that color. Red induces a green halo about it, yellow a blue halo, etc. These colors are frequently overlooked because of an effect similar to that indicated by the law of constancy, or the common sense principle, that one does not see the contrast\* color, because one has learned from past experience that the color is not present. If we look under circumstances which prevent us from recognizing the factors that usually lead us to correct our sensation, the contrast or induced color becomes evident. If a sheet of white tissue paper is placed over a gray patch on a green card, that part of the tissue paper over the gray turns to red or pink. Or if there are a green light and a white in a room, note the shadows of a pencil. The shadow cast by the green light is seen to be pink, or red. These

contrast colors were said by Helmholtz\* to be due to illusions\* of judgment. One sees what one knows to be the opposite of the inducing color. Hering\* believed that the contrast colors arise because the excess of anabolism\* in the area stimulated by the green draws the nourishing elements from the surrounding area and so produces catabolism\*, the chemical condition of red.

*Color Blindness.* A fact that confirms the belief in separate organs for different colors is that about four per cent of the male population is unable to see certain colors. Most frequently, red and green are confused. A color blind boy, when asked to sort differently colored yarns into piles of the same color, will put red, green, and sometimes, gray into the same pile. The explanation given for such phenomena varies with the particular color theory held. Helmholtz said there are red blind individuals who lack the red organs and green blind individuals who lack the green organs. Hering, on the contrary, asserted that there are only red-green blind individuals who can see neither red nor green. The question as to which of these theories is true is still in controversy, largely because the color blind individual cannot compare what he sees with what others see. He knows that he confuses colors between which others distinguish, but he cannot say whether the color he sees is bluish green, as Helmholtz assumed it should be for the green blind individual, or whether it is a grayish yellow, as Hering asserted it must be. One man who was color blind in one eye and normal in the other reported that he saw yellow, as Hering believed he should.

*Total Colorblindness and the Duplicity\* Theory.* There are people who see no colors at all, but only grays like those of a photograph. Such individuals evidently lack the cones\* in the retina\*, for they are blind in the fovea\*, where the normal eye has only cones. A difference in the relative brightness of colors when seen by the rods and by the cones confirms this assumption. If one looks in daylight at a red color and a blue, chosen to be equally bright, and then reduces the light, the colors will disappear so that each color becomes merely a gray patch. In this reduced light, the red will seem almost black, while the blue will be a light gray. This change in relative brightness of red and blue with change in intensity of illumination, is known as



the Purkinje\* phenomenon. It is explained by the greater sensitivity of the rods to short wave lengths, as compared with the cones which respond more strongly to the long waves of red. Low illumination stimulates the rods only. The totally color blind eye also sees the blue as brighter, hence we assume that the functions of such an eye are also confined to the rods. The theory that rods and cones have these different functions, the rods for brightness and faint lights, the cones for colors and not for faint lights, is known as the duplicity\* theory.

### AUDITION\*

The stimuli\* that produce sounds<sup>1</sup> are vibrations in the air. We can hear air vibrations that range from about twenty per second to eighteen or twenty thousand per second. Slow waves give deep tones, rapid vibrations or short waves produce high tones. The ear is the organ of hearing. It is thought of as divided into three parts, the external ear, the middle ear and the inner ear. We should mention that the external ear is what we popularly call the ear. To some degree the external ear collects the waves and brings them into the tube of the ear or external meatus. The waves fall upon the drum, a conical membrane that divides the outer from the middle ear. The middle ear is an air-filled irregular cavity across which stretches a chain of three small bones that conduct the vibrations of the drum to the oval window of the inner ear.

*The Inner Ear as Organ of Hearing.* The inner ear is essentially a spiral tube filled with lymph. The fluid vibrates between the oval\* window, where it receives the oscillations of the small bone, and the round\* window, which is a membrane that pushes out with each impulse from the oval window. The spiral canal or cochlea\* is divided near its middle into two parts by a ridge of bone and a membrane. The membrane is known as the *basilar\** *membrane*. On the basilar membrane is a series of cells with tufts of hairs at the ends. The fibers of the nerves of hearing end in the hair cells. Helmholtz\* asserted that the basilar membrane

<sup>1</sup> It once was customary to distinguish between noise and tone. Here we are concerned only with tone. Noise is either a very complicated unpleasant combination of tones, or a single loud blast of tone.

is composed of fibers, of different lengths, that are tuned to the tones that can be heard. The short fibers are at the bottom of the cochlea\*, the long ones at the top. The theory is that through resonance the long fibers are set into vibration by the lower tones, the shorter ones by the higher tones. The vibrating fibers

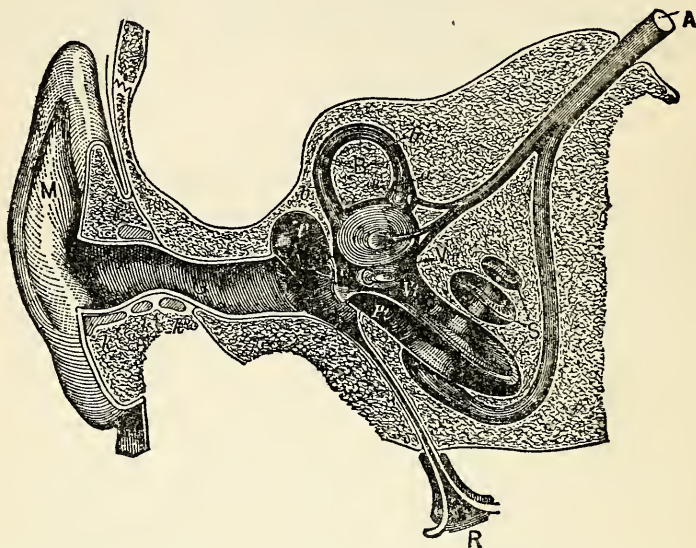


Fig. 10. Schematic section of the ear. *M* and *G*, external ear; *P*, middle ear with ossicles; *S*, cochlea; *V*, vestibule; *B*, semi-circular canal; *A*, auditory nerve; *R*, Eustachian tube. To give a sectional view, the cochlea is rotated  $90^\circ$  from its real plane. (Reprinted with permission of the Macmillan Company from Pillsbury, *Fundamentals of Psychology*, after Martin-Czermak, 1934, p. 146.)

stimulate the hair cells and through them the fibers of the auditory nerve. Recent theories tend to assume that the membrane vibrates in rather wide ribbons. Evidence has accumulated that different tones are received by definite parts of the membrane. A definite tone can be shown to produce a current of action in a restricted part of the cochlea\*. Destruction of a part of the cochlea renders an animal insensitive to a limited range of tones. Exces-

sive stimulation by a single tone destroys tissue in a restricted area of the cochlea. Wever and Bray showed that the nerves of hearing transmit electric waves that oscillate at the same rate as the sounds that are heard. Although they could not trace the vibra-

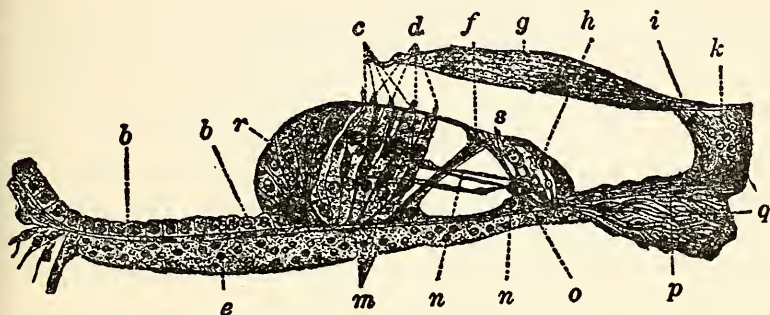


Fig. 11. Organ of Corti. *b*, basilar membrane; *d*, outer hair cells; *s*, inner hair cells; *g*, tectorial membrane; *n*, nerve fibers extending across the canal of Corti; *q*, auditory nerve. (After Retzius. Reprinted with permission of the Macmillan Company from Pillsbury, *Fundamentals of Psychology*, 1934, p. 151.)

tions to a particular part of the cochlea, they accept a modified resonance theory.

*The Resonance Theory of Vowel Qualities.* The qualities of tone or pitch correspond to the rates of vibration. The intensity or loudness of a tone varies with the amplitude of the vibration. Differences of timbre\* between the different vowels or between the same note played on different instruments are due to the complexities of the tone, or to the number of overtones\* that are present in the tones. Pitch varies with the part of the cochlea that is stimulated; intensity with the amplitude of the vibration of the part; while timbre results when different parts are stimulated at the same time to produce a sum or complex of tones. Large numbers of different overtones are added to the main vibrating part of the cochlea when a vowel is heard. The partial tones or overtones when the sound *oo* is heard are mostly of low pitch, whereas the sounds *ee* or *s* consist mainly of high over-

tones. The overtones combine with the fundamental\* tone to give the vowel quality to the whole.

*Beats in Fact and Theory.* Incidental phenomena of hearing are the appreciation of beats\*. When two tones that differ slightly in pitch are sounded together, one hears beats. The beats consist of recurrent increases in the intensity of the tone that appear as many times per second as the difference in vibrations per second of the two tones. Tones 256 DV and 260 DV beat four times per second. We have evidence that the tone that beats is of a pitch intermediate between the two tones sounded. The theory is that the beats are produced on a ribbon in the basilar\* membrane intermediate between the ribbons that vibrate for each of the tones sounded. The intermediate ribbon vibrates at the rates of each of its neighbors so that there are alternate interferences and reinforcements of its vibration.

The sound waves in the air produce oscillations of the small bones in the middle ear. These oscillations produce vibrations of the liquid in the cochlea\*. The latter vibrations, by means of resonance, affect those structures of the organ\* of Corti that are tuned to the vibrations. Stimulation of the hair cells induces in the auditory nerve\* a nerve impulse that is carried to the temporal cortex\*, where sensations of hearing are aroused.

## SENSATIONS FROM THE SKIN

The skin is a much more complicated organ of sensation\* than one ordinarily believes, but still is the simplest of the special senses. Two main forms of energy affect the skin, namely mechanical pressure, or impact, and heat. Each form of energy gives rise to two kinds of sensation and stimulates two organs. When a slight pressure is applied to certain points on the skin a sensation of pressure is felt. The sensation of pressure may be due to the stimulation of one of two simple nerve endings. One is at the roots of the hairs; the other is a slightly modified nerve ending in a corpuscle, that is found on the palms and on the soles of the feet (Meissner's\* Corpuscle). The sensations from the two endings are indistinguishable in quality. The spots that respond may be detected by moving the point of a hair over the



surface. There are from ten to twenty-five pressure spots per square centimeter.

*Sensations of Pain.* When the stimuli are of greater intensity, as compared with those of the pressure sense, they excite a different set of sense\* organs to give the sensation of pain. Pain sensations are also stimulated only on specific spots that one may find by going over the skin with a sharpened horse hair. There are from forty to two hundred of these spots per square centimeter. The organ is a free nerve ending, a simple fiber that extends into the lower layers of the epidermis. Pain sensations are aroused rather slowly. For their stimulation they require about twice as much time as the pressure spots, and have a different path in the cord from that of the pressure impulses. In short, pain sensations arise from a distinct sense organ; they are not the same in quality as strong pressure sensations.

*Sensations of Warmth and Cold.* Even more striking is the fact that there are two temperature senses which have separate organs. If the skin is touched at many spots with a warm rod, sensations of warmth are noticed at certain points. These points are much fewer than the pain and pressure spots, averaging less than one to the square centimeter. They are easily susceptible to fatigue and thus are a little harder to identify than the other sense spots. They are stimulated by temperatures above about  $33^{\circ}$  Centigrade. A cold rod, below  $30^{\circ}$  Centigrade, will stimulate sensations of cold on from six to twenty spots per centimeter. We have indirect as well as direct evidence that warmth and cold are different senses. The direct evidence comes with mapping of the spots. Indirect evidence is offered by difference in the rate at which the two organs may be stimulated. Cold spots are excited more quickly than warm spots. Cold spots may be stimulated by menthol, warm spots by carbon dioxide. The temperature at which warmth changes to cold is known as the physiological zero point. This point varies with the temperatures to which the skin has been subjected before a test is made, but is generally found at temperatures from below  $30^{\circ}$  up to  $36^{\circ}$  or thereabouts. If we keep one hand for a time in water of a temperature of  $20^{\circ}$ , and the other hand in water at a temperature of  $40^{\circ}$ , and if we then put both hands into water at a temperature of  $32^{\circ}$ , the water will

feel warm to the hand removed from cold water, and cool to the hand removed from warm water.

*Paradoxical\* Cold.* The fact that we speak of cold as a real form of energy, while the physicist assures us that it is only a lesser heat, is probably due to the presence of the specific quality of sensation. Extreme heat as well as extreme cold stimulates the pain spots which give the sensations of burning heat or biting cold. Observers have also asserted that cold spots are stimulated by temperatures above  $45^{\circ}$ , approximately, and have suggested that what we call hot is a mixture of sensations of warmth with sensations of cold (paradoxical\* cold). Jenkins, with carefully controlled work, failed to find evidence of such stimulation when he used small areas. Further investigation of this question is needed.

### SENSATIONS OF TASTE

Sensations of taste (gustation\*) have also been analyzed into a relatively small number of simple qualities. Sensations of taste are derived from the tongue, of course, but also, in a lesser degree, from the back of the mouth and the larynx. Four tastes are recognized as simple: sweet, salt, sour, and bitter. They are somewhat differently distributed on the tongue. Sweet is most readily tasted at the tip, bitter at the back, and sour on the edges, but salt is rather more evenly distributed on the tip and edges. The sense organ is a budlike grouping of nerve fibers (and epithelia) several of which are found in the papillae of the tongue. The papillae comprise the small red spots (that may be seen in a mirror) on the tip of the tongue, and a group of about nine larger ones, the circumvallate, arranged in a V on the back of the tongue. From one to four different tastes may be found in each papilla. The papillae, which are receptacles to catch the liquid that contains the substance being tasted, permit the liquid to come into contact with the taste\* buds. Stimulation is through chemical reactions, but the more intimate nature of the response is not yet known.

Sensations of taste mix with the four skin sensations and with smell to produce the qualities of food. We do not usually distinguish the addition of extra qualities but call them all taste.



There are some indications of contrast in tastes. For instance, salt increases the strength of sweet.

### SMELL

We have less direct knowledge of the elementary sensations and the corresponding organs for smell than for the other senses. The nose is well known to be the organ of smell. The sense organ is spread on the upper part of the nasal cavity and communicates directly with the olfactory bulb on the lower surface of the brain. The olfactory\* area is marked by a brown color. The sense organs are small fibers that end in a tuft of hair on the surface. The substances smelled are carried to the membrane by the air inspired from the outer world or by air expired from the mouth. They react chemically with the organ of smell.

*The Smell Prism.* Henning\*, whose work on smell is generally accepted, finds that there are six distinguishable qualities of odors:

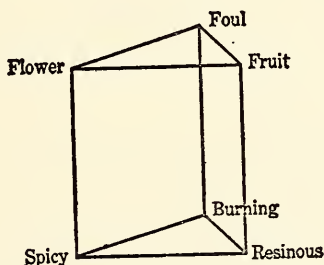


Fig. 12. Henning's Smell Prism. The primary qualities are at the corners, and intermediate smells are on the lines between. (Reprinted with permission of the Macmillan Company from Pillsbury, *Fundamentals of Psychology*, 1934, p. 189.)

spicy, resinous, burned, fragrant, ethereal, and putrid. A gradually changing series of qualities is found intermediate between each pair. Henning arranged the odors on a prism with a simple odor at each corner and the intermediates on the connecting lines. There is evidence of fatigue or adaptation in smell. Odors become less obvious as stimulation continues, and some of the components fade more rapidly than others, so that an odor un-

pleasant at first may become less unpleasant with time. Little advance has been made in correlating the chemical composition of odorous substances with the odors. Smell sensations also mix with cutaneous\* sensations from the nose, as in the case of pungent odors that stimulate the nerves\* of pain. They also combine with taste, as in the sweet smell of chloroform or in the sour smell of vinegar.

Odors mix much as do colors, but there is little evidence of contrast or compensation. Odors hide each other through suppression of a faint odor by a more intense one. Earlier writers found some evidence of contrast and compensation, but this conclusion was not confirmed by Henning\* and may, therefore, be regarded as an open question.

### KINAESTHETIC SENSATIONS

Often confused with sensations\* from the skin are sensations from the muscles and tendons, that give evidence of the movements of the members. In the body of the muscles and in the tendons are numerous sensory nerves which are compressed whenever the muscle contracts or the tendon stretches. The sensations from these nerves give one an awareness (kinaesthesia\*) of the position of the parts of the body and of its movements. They also excite reflexes\*, and they automatically control the movements of the body through the cerebellum\* and, probably, through the cord as well. When the paths in the cord, which conduct these impulses to the brain\* are destroyed, movements become very inaccurate. This is the case in locomotor\* ataxia, also called tabes\*.

### SENSE OF EQUILIBRIUM\*

What has sometimes been called a sense, but what probably gives only impulses for the automatic control of the movements of the body, is the group of structures in the portions of the ear that are not concerned with hearing; namely, the sacculus, utriculus (utricule\*) and semi-circular\* canals. These structures are alike in that all contain hairs which float in the liquid of the vestibule\* and which are moved (while the liquid remains stationary through inertia) when the bone that contains the

liquid moves. These movements stimulate the vestibular branch of the nerve of hearing, that connects with the cerebellum and the centers for moving the eyes. The semi-circular canals are arranged in the three planes of space and as the head moves, the canal in the corresponding plane is excited. The sacculus and utricle probably are most affected by the movements of the body as a whole, up and down and forward and back. Stimulation of the organ when the head is turned in one direction auto-

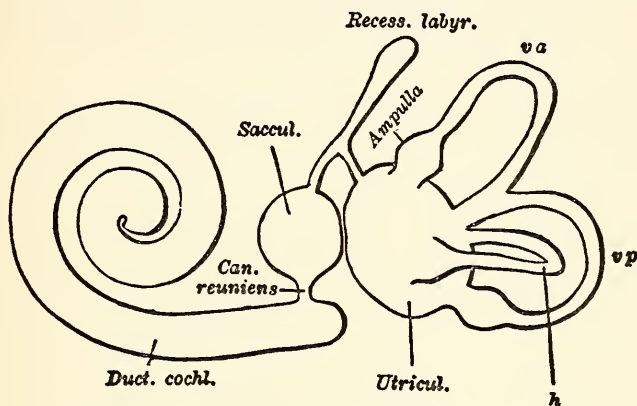


Fig. 13. The membranous labyrinth of the ear, to show the organ of balance. *Saccul.*, the sacculus; *Utric.*, the utricle; *va*, *vp*, and *h*, the semicircular canals. Cochlea at the left. (Reprinted with permission of the Macmillan Company from Pillsbury, *Fundamentals of Psychology*, 1934, p. 194.)

matically turns the eyes in the opposite direction so that the object looked at is still fixated in spite of the movement. They also stimulate the digestive tract to give rise to movements of the stomach, thus causing giddiness and, in excessive stimulation, sea sickness. One is aware of stimulation of the vestibular nerve only through the movements excited by the nerve.

## ORGANIC SENSATIONS

In addition to the special senses, there are many sense\* organs within the body that give an idea of its well being. Sensations from these organs are usually fused into large masses and are not

analyzed. On the border line between special senses and these general ones are hunger and thirst. Experiments in recent years have shown that hunger accompanies contractions in the stomach wall, that begin after the stomach has been empty an hour or so and continue for a day or more. The contractions cease after long fasting, except when food is seen or thought about. Thirst is caused by dryness in the back of the throat. Thirst may be removed by moistening the membrane of the throat with a fluid such as citric acid, or by increasing the fluid content of the blood. Fluid may be introduced into the blood stream by direct injection or, normally, through the stomach.

### INTENSITY OF SENSATION—WEBER'S\* LAW

Although qualities of sensation can be named and enumerated, intensity of sensation shows only a gradual change and therefore cannot be analyzed into nameable units. One generalization regarding sensation intensities which has been thoroughly established is that the least noticeable difference between intensities of sensation is within the limits of a constant fraction of the total energy applied to produce the sensation. Weber\* first noticed this relationship in experiments with lifted weights. He found that he could just discriminate between weights of forty and forty-one grams, but that the weight least noticeably different from eighty grams is eighty-two grams. Each of the senses has been found to have its own fraction of least noticeable difference, with a wide range of variation for different individuals and for different conditions of experimentation. For vision, one can discriminate from  $1/60$  to  $1/100$  of the standard; for lifting weights, from  $1/40$  to  $1/55$ ; for tones, from  $1/5$  to  $1/11$ ; for smell,  $1/3$  to  $1/7$ ; for passive pressure on the skin,  $1/5$  to  $1/7$ ; and for taste,  $1/3$  to  $1/5$ . Weber's Law (1834) became the basis for the development of the new science of psychophysics by Fechner (1860). Fechner, interested in studying the relationship between mind and body, conducted numerous experiments to quantify the amount of stimulus which must always be added to a comparison stimulus in order for man to experience a sensation of just noticeably different magnitude. He then formulated what is now known as the Weber-Fechner Law. This prin-

ciple states that with the increase in intensity of the stimulus by a constant ratio (Weber's contribution), the magnitude of the sensation increases by equal increments or steps. This relationship, when stated mathematically, is a logarithmic one. The Weber-Fechner Law, although now known to be only an approximation of the truth, has been extensively applied in the sense modalities of vision and audition. Fechner became known as the founder of modern psychophysics, in which the purpose is still to quantify the relationship between the magnitude of the stimulus and the magnitude of the experience.

*The Absolute Limen\**. The least noticeable difference is greater when the absolute stimuli are very small or very great. The fractions given above hold only for the moderate intensities of sensations. The figures indicate the comparative sensitivity of the different senses. Another indication of comparative sensitivity is the least stimulus\* that will affect the particular sense\* organ. All senses have a lower limit below which no sensation is appreciated. For sight and sound, the least amount of energy that will affect the sense can be given in units of energy, ergs. The limiting intensity is known as the limen\*. For sight the limen is about  $1 \times 10^{-8}$  ergs. The least energy that will excite the ear is even less. Both senses are affected by stimuli that cannot be detected by physical instruments. Pressure on the skin is the only other absolute limen that can be measured in energy units. This limen has been given as about a thousandth of an erg. Measurements of the chemical energy exerted on the tongue and olfactory membrane cannot readily be reduced to units of energy. The nose, however, is for some substances about as sensitive as chemical methods for detecting the presence of a substance.

## TEST QUESTIONS

A. *True-False Statements*. Study each statement and decide as to its truth or falsity.

1. If a pain spot is stimulated by cold a sensation of cold is felt.
2. The rods enable one to see red.
3. The visual purple increases the sensitivity of the rods after they have been ten minutes in the dark.



4. Vision of red is followed by green.
5. Blindness to blues is the most frequent type of color blindness.
6. Helmholtz assumed that all colors may be compounded of red, green and blue in the right proportions.
7. Red is the complement of yellow.
8. Hering asserts that complementary colors neutralize each other and then the black-white organ is stimulated to produce a gray of the suitable shade.
9. The rod and cone layer is innermost, nearest the light.
10. The middle ear contains lymph, or water with dissolved salt.
11. The liquid of the inner ear is forced to vibrate at the rate of the sounding body, by the intermediary of the air and the chain of ossicles.
12. Hearing a loud tone for too long a period renders the entire organ of Corti insensitive to that tone.
13. Vowel sounds vary with the pitch of the fundamental.
14. Sounds with a vibration rate higher than 20,000 are not heard by man.
15. Beats are heard on fibres between the two that respond to the beating fundamental.
16. Electric waves, tuned to the tones heard, may be detected in the auditory nerve.
17. Pain is an overstimulation of the pressure spots.
18. Pressure can be felt on the hairs or over roots of the hairs.
19. The physiological zero point is the same as absolute zero.
20. Cold is felt when the warm spots are only slightly stimulated.
21. Warm spots are stimulated by CO<sub>2</sub> gas at 30° Centigrade.
22. The papillae on the tongue are the organs of taste.
23. Bitter may be appreciated on the tip of the tongue more easily than anywhere else.
24. There is but one taste quality received from a single papilla.
25. Salt on a slightly sweet substance increases its apparent sweetness by contrast.
26. Nauseating is a real primary odor.
27. We can smell with the back of the tongue.
28. Henning asserted that spicy, resinous, burned, fragrant, ethereal, and putrid are the true primary odors.
29. Turning the head disturbs the hairs in the semicircular canals and gives rise to a sensation.



30. Hunger is felt when absence of food over a period of time produces contraction of the stomach walls.
31. The fraction of Weber's law for sight is  $1/10$ .
32. One can remember different intensities of sensation just as one recalls the color yellow.
33. Weber's Law and the Weber-Fechner Law are identical in meaning.

B. *Completion Statements.* Read the incomplete statements and decide on the words that would complete each statement.

1. The quality of a sensation is dependent upon \_\_\_\_\_ and upon \_\_\_\_\_. The more important is \_\_\_\_\_.
2. The fovea of the retina is the \_\_\_\_\_. The structures in the retina sensitive to light are the \_\_\_\_\_.
3. Wave lengths of light to which the retina is sensitive range from about \_\_\_\_\_ mm. to \_\_\_\_\_ mm.
4. The complementary color to blue is \_\_\_\_\_, to red is \_\_\_\_\_.
5. If a red and a green are of the same brightness in daylight, the \_\_\_\_\_ will be much brighter when the light is reduced to the degree that both seem gray.
6. The pitch of a tone varies with the \_\_\_\_\_ of the vibrations. The intensity varies with the \_\_\_\_\_.
7. Low tones are heard with the \_\_\_\_\_ portion of the cochlea, high tones with the \_\_\_\_\_ portion.
8. Beats are produced by the vibration of tones that by \_\_\_\_\_ vibrations. The beat tone stimulates an \_\_\_\_\_ fiber in the basilar membrane.
9. Pressure and pain are different sensations because:  
 (1.) \_\_\_\_\_  
 (2.) \_\_\_\_\_  
 (3.) \_\_\_\_\_
10. The four fundamental taste qualities are \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.
11. The organ of smell is in the \_\_\_\_\_ part of the \_\_\_\_\_ . It is stimulated by \_\_\_\_\_ carried in the \_\_\_\_\_.

12. The organs of balance are found in the \_\_\_\_\_ of the \_\_\_\_\_
13. The just noticeable difference between two sensation intensities is  
 $\frac{1}{10}$  for sight;  $\frac{1}{100}$  for lifted weights.

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## CHAPTER FOUR

### *Individual Differences*

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#### HISTORY

THE FACT THAT men differ from each other has long been recognized. The Greek philosophers of the Golden Age intimated as much. Not until the latter part of the nineteenth century, however, did any scientist attempt to measure these differences. Francis Galton\* (1822-1911), the English experimentalist known as the "father of individual differences," noted variations in memory images which his colleagues reported in their descriptions of a breakfast scene they had previously experienced. To state these differences in quantitative terms, Galton made use of statistics\* and developed that science\* as a tool in psychology. Indeed, it was he who stimulated the work of Karl Pearson\* (1857-1936), the English mathematician-psychologist, in the method of correlation\*. The pioneer work of Galton and Pearson, and that of Cattell\*, has shown clearly that, although men are more similar to each other than they are dissimilar, differences in intelligence, personality, physique, and all other characteristics do exist. It has likewise been established that men differ only quantitatively from one another in respect to any trait. One possesses, in other words, an *amount* or *degree* of a characteristic. No normal person can be said to be wholly lacking in any trait\*. Differences in intelligence\*, for example, are differences only in degree. Men range from high to low on traits which have been measured.

## HOW INDIVIDUAL DIFFERENCES ARE STUDIED

Before the psychologist can measure he must construct measuring sticks. Psychologists have constructed numerous "meter sticks" known as *psychological tests*. These tests are composed of a great many items to which each subject\* reacts. Credit on the tests is given either as *numerical* points or as *developmental* months for the total number of items successfully "passed." In this way, a score on the test is earned by each individual. Numerous scores are accumulated from a large number of subjects who have taken the various psychological tests. The tests, as measuring rods, are classified on the basis of the following criteria or standards: (1) *what the test measures* (intelligence\*, sensory acuity, motor\* co-ordination, personality\* traits\*, character\* traits, vocational interests, aptitudes\*, school achievement\*, reasoning\*, memory\*, attention\*, attitudes\*); (2) *how the test is administered* (to an individual, to a group, by verbal or non-verbal procedures); (3) *how much time is allowed* (power tests, no time limit, or speed tests, with definite time limits).

Because people differ quantitatively in characteristics, tests constructed to disclose their traits and abilities must be reliable\* and valid\*. To be reliable a test must measure *consistently*, i. e., give the same score when the test, or its equivalent form, is re-administered to the subject. The degree of reliability of a test is measured by *correlating* the scores made on the test with the re-test scores made by the same individuals. To be *valid* a test must measure what it purports to measure. Validity of a test is determined by correlating\* the scores of many persons with the scores earned by the same people on a second measuring rod accepted as a measure of whatever the first test purports to measure. The techniques used to establish reliability\* and validity\* of psychological tests are thus outgrowths of the science of individual\* differences. If people did not differ quantitatively, measurement would not be necessary and psychological tests would not exist.

To measure quantitative differences among human beings, a psychological test is administered to a random\* sampling of sub-

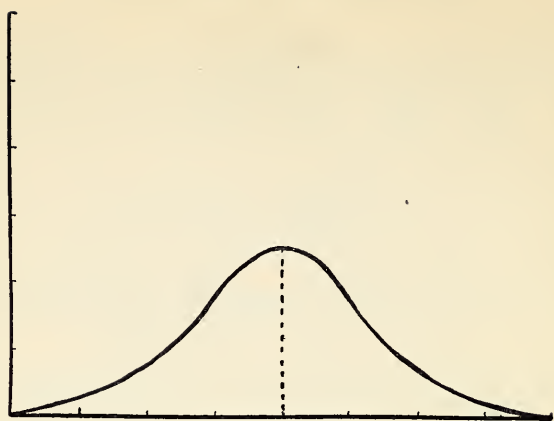


Fig. 14. The bell-shaped curve. Note that the three measures of central tendency coincide in the normal distribution curve. (Reprinted with permission of the Odyssey Press from Vaughan, *General Psychology*, 1939, p. 624.)

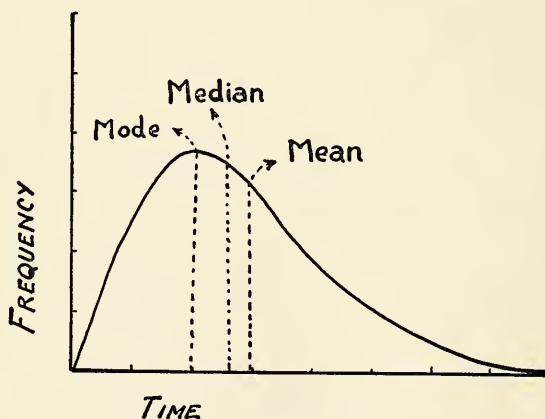


Fig. 15. The skewed curve of distribution. Note that the mode in the skewed curve is off center. The distribution may be skewed either to the right or left of center. In these curves the mean, median, and mode have different values. (Reprinted with permission of the Odyssey Press from Vaughan, *General Psychology*, 1939, p. 624.)



jects\*. The scores made by the subjects are charted on a graph.\* The scores of those individuals who pass the greatest number of items are indicated at one extreme of the graph, and the scores of those who pass the least number of items are indicated at the other extreme. Most people will find their scores aligned between these two extremes. When the uppermost points of each pile of scores are connected by a line, a curve is obtained of one of the following types: (1) the *symmetrical\**, in which the curve is bell-shaped\* and has one peak in the middle; (2) the *skewed*, in which the curve is *asymmetrical* because the peak is displaced to one side of the center (skewness\*); (3) the *multi-modal\**, in which the curve shows two or more peaks or modes\*. If there are only two peaks, the curve is called bi-modal\*. This third type of curve is obtained when the subjects are not selected at random from the population or when the measurements are defective. Because the symmetrical curve is the one most frequently obtained it is called the "normal\*." Any distribution of scores, however, indicates the fact that people differ. Figures 14 and 15 illustrate what is meant by the normal and the skewed distribution curves.

## SCOPE OF THE LAW OF INDIVIDUAL DIFFERENCES

In practically all situations in which the responses of random samplings of human subjects have been measured the normal\* distribution curve is obtained. The principle of individual\* differences applies, thus, not only to man's abilities to learn, remember, think, and reason (all these are often called the higher mental processes), but also to the measurement of physique (height and weight, for example), and to the scores made on tests of personality and character. Because the differences which men show on tests are universal the psychologist often speaks of the distribution of scores about a central point as the *law\** of individual differences. Indeed, it has been held that if a random\* sampling of subjects on a test fails to yield scores which conform to the general outlines of the bell-shaped\* curve, the measuring instrument must be faulty or the test poorly administered.

## MEASUREMENT OF THE EXTENT OF INDIVIDUAL DIFFERENCES

Man is not satisfied with the knowledge that people differ from each other. He wants to know how much they differ. To answer this query statistical\* treatment of the raw\* scores is necessary. First, the location and magnitude of central\* tendency are determined by calculating one of the following averages: (1) the arithmetic\* mean; (2) the median\*; (3) the mode\*. The arithmetic mean is computed by dividing the sum of the scores by the number (N) of cases. The median, defined as the value of the middle score when the raw scores are arranged according to their magnitudes, is obtained by selecting that score which divides the array into halves. The median is used when only a few subjects are studied or when a few extreme scores would markedly influence the mean. The mode\*, defined as the most typical score, is obtained by noting the only score which is most frequently represented. The mean, median, and mode are approximately the same in a symmetrical\* distribution. In a skewed distribution, the median and mode are often used as measures of central\* tendency. Any measure of central tendency, therefore, (1) tells us about the performance of the group as a whole, and (2) affords us a basis for comparison with other groups on the same measuring instrument.

Man wants to know not only the arithmetic\* mean for his group, but also how far *above* or *below* the average his score is. A measure of scatter\*, or *dispersion*, from the central\* tendency is needed. Three measures of scatter, frequently used, are the range\*, the mean deviation or average\* deviation (A. D.), and the standard deviation (S. D.) or sigma\* ( $\sigma$ ). The range\* is the difference between the highest and lowest scores. The average\* deviation is the mean of the deviations\* of the scores from the average\* of the distribution\*. The standard\* deviation, defined as the root-mean-square of the deviations from the arithmetic\* mean, is the third measure of scatter. To obtain the standard deviation (*sigma score* or S.\* D.) the formula

$$\sqrt{\frac{\sum d^2}{N}}$$

is used in which  $d^2$  is the sum of the deviations from the mean, squared, and  $N$  is the number of cases. The S. D. measures distance away from the mean\* in either direction along the base line (x-axis) of the distribution curve. In a perfectly normal\* distribution,  $+1.00$  S. D. to  $-1.00$  S. D. includes 68.26 per cent of the scores, while two sigma\* include 98.46 per cent. Three sigma on either side of the mean include 99.73 per cent of the cases. Given the mean and sigma scores of the distribution, one can readily determine how far above or below the average his score lies by calculating the standard\* score. An illustration follows. If A's raw\* score is 70 on a scholastic achievement test in biology, what does the score mean? Assume the average for the group to be 50 and the S. D. to be 10. A's deviation from the average is  $+20$ .  $20 \div 10 = 2$  units *above* the average. A's standard\* score is therefore,  $+2.0$ . Had A's raw score been 30 his standard score would have been 2.0 units *below* the mean. By this method a student can easily determine his standing in any class or on any psychological test. At the close of this chapter are found illustrative problems.

## VARIATIONS WITHIN THE INDIVIDUAL

The existence of individual\* differences has been demonstrated by administering identical tests to the members of a group. Is each subject\* equally good, bad, or indifferent on all the tests he takes? If so, the psychologist, after having administered only one test, can prophesy (predict) the subject's score on any other test. If not, different tests must be given to determine the *relationships* between the subject's scores on the various tests. Analysis of results indicates clearly that *variation* within the scores made by each subject on different tests *is the rule*. To determine the relationships between these diverse scores, Karl Pearson\* devised a method by which the degree of relationship among these scores could be calculated. The result is always a *number* which expresses the degree of correlation\* (or relationship) between the sets of scores. This number is symbolized by the letter  $r^*$  and is called the coefficient\* of correlation. The range of  $r$  is from a perfect positive relationship,  $+1.00$ , through 0 (indicating an absence of relationship), to a perfect *inverse* relation designated as  $-1.00$ .

If each of a group of subjects, when given intelligence\* tests and musical aptitude\* tests, made comparable scores on each test, a score on one of the tests would indicate the score on the second test. A plus 1.00 coefficient of correlation would result. If the score of each subject were high on the intelligence test, but low on the music test, an inverse or  $-1.00$  coefficient would obtain. If no relationship existed between the scores made on the two tests a zero\* coefficient would be indicated. Perfect positive and perfect negative coefficients are rarely found. The relationship between intelligence and musical tests (such as in pitch discrimination) is low positive.

Coefficients of correlation *never* indicate cause and effect relations. They do show that an individual's score on one psychological test is usually related in a positive degree to his score on a second. Accordingly, if a subject earns a high score on one test, he is not likely to be mediocre on a second test. We may also conclude that the so-called Doctrine of Compensation\* does *not* hold. This doctrine states that "Nature" has observed the principle of justice in having provided man with "bad" traits to balance the "good." According to this false notion, an athlete is expected to be a poor student; a "dumb" girl to be beautiful! *Correlation\* between traits rather than compensation for traits is the rule.* Coefficients\* of correlation between scores on some tests are higher than they are between scores on still other tests. This finding has led psychologists to formulate the "cluster" theory of man's abilities. By this they mean that certain human traits\* appear to be closely related to each other, whereas certain other traits are associated with a quite different group of reaction\* tendencies. These clusters are (1) intelligence\*; (2) athletic ability; (3) mechanical ability; (4) possibly social effectiveness. The following statements illustrate two interpretations of the correlation\* method when that method is applied to the question of the degrees of relationship among scores earned on various psychological tests. A man superior in mechanical ability may be of average or better than average intelligence, just as the superior athlete may be. The individual who is superior in getting along with others may possess average or better than average mechani-



cal ability. The student who is superior in sports will show this superiority in most types of athletic activity.

### FACTORS WHICH DETERMINE INDIVIDUAL DIFFERENCES

1. Individuals make different scores on psychological tests because of different heredities\*. The genes\* and chromosomes\*, the bearers of hereditary factors, are known to vary in their combinations, and, consequently, are said to make for variability in physical as well as mental characteristics. This variability has been shown by studies of the intelligence test scores of identical\* and fraternal\* twins as well as of siblings\* and cousins. The less the blood relationship the less the degree of positive relationship between the two sets of intelligence test scores. Similar hereditary backgrounds make for similarities in test scores among the subjects. Different heredities make for differences in test scores. The degree to which heredity determines one's intelligence test score, however, cannot be expressed as a numerical value, since the role of environmental factors cannot be completely isolated from the hereditary.

2. People differ because of differences in *environments*. They differ because not all environments permit *equal opportunity to learn*. This inequality of opportunity is illustrated by the finding that children who are superior on intelligence tests usually come from semi-professional and professional homes. Although a superior heredity\* is undoubtedly indicated in this finding, the result does suggest that the superior environment also may well have made for greater opportunity to learn. Studies of *foster children*, adopted into superior environments, indicate similar beneficial effects. The degree to which men differ in mental and behavioral characteristics is thus influenced by the opportunities available for learning. This conclusion is supported by controlled\* experiments to test the influence of equal practice intervals upon initial scores made by adult subjects on selected psychological tests. The results indicate that although those with the lowest initial scores show the greatest gains, equal time spent in practice increases individual differences. *Practice* makes for differences.



3. *Race and sex* were once assumed to act as powerful determiners of individual differences. While it is granted that these two factors may make for differences in physical appearances, it has not been demonstrated that they make for marked differences in responses on psychological tests. Unusual deviations\* between the members of different races or between sexes can be explained in terms of cultural (environmental) factors as well as in terms of innate\* sex or racial characteristics. Studies of the effect of age upon the extent of individual differences in behavior show that the subject, as a child, as an adolescent, and as an adult, tends to maintain his initial relative position in his group.

The independent factors making for differences between human beings of similar or dissimilar heredities and cultures are not readily isolated by experimental means. The multiplicity of causes of individual differences, therefore, requires that interpretations on this question be phrased with caution.

### APPLICATIONS OF INDIVIDUAL DIFFERENCES

1. *In education.* The principle of individual differences has numerous implications for modern pedagogy.

First, since every distribution of scores earned by a random\* sampling of subjects\* is uni-modal (one mode\*) and never multi-modal\*, school children cannot be classified into arbitrary and preconceived groups for the purpose of differential instruction. The classification of pupils, for example, on the basis of the lauded standard of general intelligence\* results in wide individual differences between the pupils in other personality\* characteristics equally important in the educative process. If children, therefore, are to be grouped for specialized instruction, the basis for classification must rest not only upon the status of mental development, as determined by scores earned on mental\* age scales, but also upon the degrees of social and emotional maturity\* of the pupils. Only if these requirements are met can the group be considered psychologically more *homogeneous* for instructional purposes. One difficulty in using these criteria for classification is the absence of well standardized\* tests for the measurement of social and emotional development in children. To the degree that

homogeneous grouping can be adequately effected, then, to that degree is the range of individual differences in intelligence, and in social and emotional development reduced.

Second, the fact that scores earned by school children on standardized examinations show a wide range suggests the importance of the individual child as the center of the modern school system. Accordingly, modern educators realize the need for teachers trained in educational psychology. Knowledge of each child requires careful and unprejudiced study. It requires the rejection of the notion that children can be adequately trained by mass methods devised to teach the "average"\*. Each individual is unique. Each child must be treated as an individual in the classroom.

Third, differences between pupils at any level of instruction necessitate frequent and careful revisions of the curriculum. Social change is accompanied by changes in needs, interests, and attitudes. The curriculum must be adapted to these changing needs. At one time in the history of education, pupils were required to study Latin and mathematics because these subjects were believed to "strengthen the mind." This notion, fortunately, is no longer accepted. The curriculum now permits the student, within limits, to elect a course of study coincident with his needs, interests, and abilities. Courses of study are, therefore, undergoing continuous revision, the ultimate goal of which is the adjustment by the school to the needs of its pupils. The principle of individual differences underlies this continuous change shown by the curriculum and by the development of new methods in classroom instruction. In this way the controversial question of homogeneous\* versus heterogeneous\* groupings of pupils is resolved. Since no final proof of the superiority of the former over the heterogeneous method has yet been reported, curricular adjustment to the basic problem of human variability\* appears more feasible.

The psychologically trained teacher is well equipped to understand the individual pupil. In the modern child-centered school the teacher can readily obtain data by which to plot a psychograph\* or psychological profile for each student. Figure 16 is illustrative. The profile, one for each child, consists of a series of

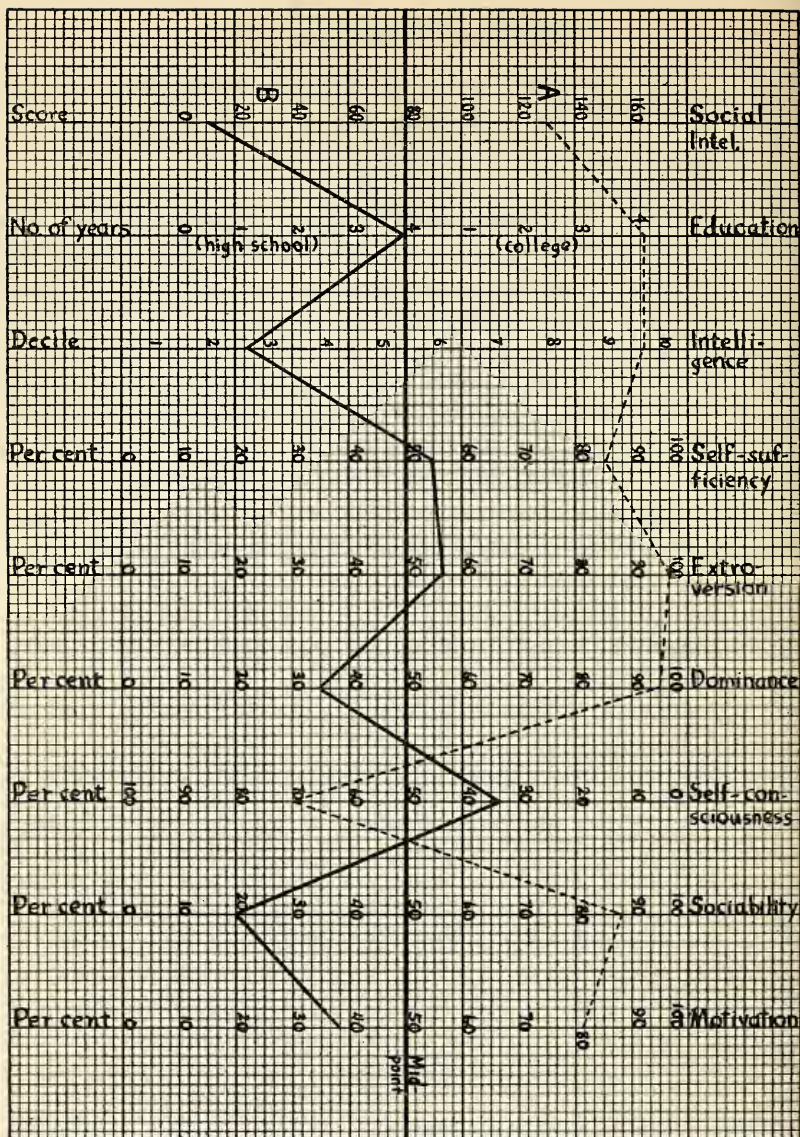


Fig. 16. A psychograph based upon scores earned by two individuals on a series of standardized tests. Note the use of standard scores. (Reproduced with permission of the author and the Odyssey Press, Inc., publishers, from Vaughan, *General Psychology*, revised edition, 1939, p. 619.)



points each representing the child's standard\* score earned on various school achievement tests (reading, spelling, arithmetic), a *battery* of intelligence tests, and on several aptitude and interest tests. Standard scores are used on the profile because they tell the teacher the relative placement of the child in the school's population. The profile, however, is not relied upon exclusively by the psychologically trained teacher. The recency with which psychological tests have been developed precludes the possibility that each aspect of the pupil's personality\* can today be accurately quantified. Although psychological tests can and should be used to advantage, additional aids have been shown to be helpful. To aid in the interpretation of scores earned by the child on psychological tests the modern teacher also uses data collected by observation of the child at play, at work, and, if possible, at home. Data from these behavior\* samples yield a more complete picture of the individual boy or girl.

Techniques, such as we have just described, illustrate the application of salutary rules of conduct and pedagogy formulated by the leaders of the mental\* hygiene movement. This modern program aims to train the child to live happily and effectively in society by always resolving in a socially and personally satisfying manner the problems of daily life. The modern school and the mental hygiene movement are one in that each applies the principle of individual\* differences in the attainment of its aims.

2. *In vocational guidance.* To aid the individual to find his place in the vocational world, counsellors study the general intelligence, special abilities, interests, and social attitudes of those who discuss this problem with them. For the collection of these data the counsellor relies upon standardized\* psychological tests and behavior samples. Successful men and women in one vocation, such as journalism, are more similar in their interests than they are to workers in other occupations, such as medicine and law. The measurement of one's interests, therefore, yields knowledge useful for guiding the young man or woman in the selection of a life work. Vocational interest schedules, like other psychological tests, illustrate the principle of individual differences.

3. *In law.* The lawyer knows that one witness may observe an

accident in a different manner from another witness. He knows that one witness may remember better than a second. One witness, more emotional than another, may react quite differently under cross-examination. These illustrations suggest the part which the principle of individual differences plays in the legal profession.

4. *In industry.* The selection of employees in business and industry illustrates recognition of man's uniqueness. *Job\* analyses* are made to determine the needs for each vacancy. Applicants are tested under standardized shop conditions to determine, in turn, how closely they fulfil the specifications of the job analyses. Profiles\* are often constructed to help disclose one's qualifications for particular occupations or positions. In this way the vacancy is filled.

5. *In attitude measurement.* An attitude\* may be defined as an acquired, relatively specific predisposition, accompanied by a degree of feeling tone, to react toward a given situation. Only recently have these reactions been measured. L. L. Thurstone\* (1929) has devised an opinion or attitude scale consisting of from twenty to thirty statements which range in meaning from the highly favored to the extremely disfavored. Scales of this type have been constructed for the quantification of man's attitudes toward a number of social institutions and controversial issues. Among these are scales for the measurement of opinions about the church, the law, the Bible, communism, fascism, prohibition, birth control, the Negro, and the Chinese. On each schedule the subject checks only those statements with which he is in complete agreement. Each statement has already been assigned by statistical procedures a numerical value. This number indicates the position of each statement along a line extending from complete endorsement to complete rejection of each issue. The calculation of average scores for persons taking the various scales is easily done.

Thurstone's\* opinion "tests" indicate the degree of one's acceptance or rejection of an issue without yielding information apropos of the causal factors influential in the development of the attitude. The scores obtained show the presence within the personality of preconceived, relatively inflexible, emotionally-toned



notions called stereotyped\* attitudes. That these stereotyped opinions influence human behavior is readily illustrated in conversation on controversial questions. Appeal to these stereotypes is one characteristic of *propaganda*.

Modifications of the Thurstone technique have been made by Remmers (1933) and Stagner (1936). Analysis of the results obtained thus far indicate that a number of factors are needed to account for the different scores made by people checking the questions of the scales. Intelligence\*, geographical location, the nature of the culture at the time of administration, religious training, and other factors are among those believed to act as antecedent causes. For these reasons, then, it is difficult if not impossible to speak of attitudes in the general sense. Accordingly, the prediction of the outcome of a state or national election (by means of various "polls") is a difficult one. One of the chief difficulties encountered in the measurement of opinions offered by a large number of people is the adequate selection of random\* samples within the territory. That progress is under way toward the solution of this problem has been indicated by the success of certain well known research organizations for the study of public opinion. The measurement of attitudes is obviously necessitated by the fact of individual differences.

6. *In everyday life.* Differences between people require the acquisition of a tolerant attitude toward these individual variations. The realization that people differ from each other and that definite causes of such differences exist, helps us to understand ourselves as well as others.

## ILLUSTRATIVE PROBLEMS

Assume a symmetrical\* distribution of the following scores made by 15 students on an *achievement*\* test in a college class:

<i>Student number</i>	<i>Score</i>	<i>d (deviation*)</i>	<i>d<sup>2</sup></i>
1	35	17	289
2	42	10	100
3	77	25	625
4	76	24	576
5	52	0	0
6	52	0	0
7	52	0	0
8	60	8	64
9	67	15	225
10	66	14	196
11	26	26	676
12	43	9	81
13	52	0	0
14	41	11	121
15	40	12	144
Sum	781	171	3097

*Measures of central tendency*

$$1. \text{ Average or mean } \frac{781}{15} = 52$$

$$2. \text{ Mode } = 52$$

$$3. \text{ Median } = 52$$

*Measures of scatter*

$$1. \text{ Range } = 51 \text{ (from 26 to 77)}$$

$$2. \text{ A. D. } = \frac{171}{15} = 11.4$$

$$3. \text{ S. D. } = \sqrt{\frac{3097}{15}} = 14.3$$

*Standard Score, Student No. 1.*

$$35 - 52 = -17 \text{ (below the average)}$$

$$\frac{-17}{14.3} = -1.1 \text{ standard units below the average}$$

Problem: Add alternately 5 and 10 to the raw scores made by the 15 students. With this new distribution determine the values for each of the measures of *central tendency* and of *scatter*.

## TEST QUESTIONS

A. *True-False Statements.* Study each statement and decide as to its truth or falsity.

1. A reliable test measures what it purports to measure.
2. All psychological tests are intelligence tests.
3. An intelligence test is a psychological test.
4. The existence of standardized tests implies that people differ in degree one from another.
5. A group of ten year old morons would constitute a random sampling for the study of differences in I. Q. among ten year olds.
6. The median is a measure of dispersion.
7. B's standard score is  $-2.61$ . This means he is far above the average.
8. Among identical twins heredity makes for similarities on intelligence tests.
9. The method of correlation has been used in the development of the cluster theory.
10. Hereditary and environmental factors have not as yet been isolated one from another in the study of the causal factors for individual differences.
11. Men differ only on intelligence tests.
12. Men can be separated into "types" on the basis of their scores on psychological tests.
13. The uni-modal curve and the bi-modal are one and the same.
14. Scores earned on Thurstone's attitude scales often reveal stereotyped opinions.
15. To be accurate an adequate sampling of the population is essential in the measurement of public opinion.
16. Homogeneous grouping has been shown superior to the method of heterogeneous instruction.
17. The most accurate measure of scatter is the range.
18. Recognition of the importance of individual differences has aided in the development of the child-centered school.
19. Attitudes, as evidenced by scores earned on scales, vary in time and place.

20. Scores obtained by way of standardized tests can advantageously be supplemented by data yielded by the behavior sample.

B. *Completion Statements.* Read the incomplete statements and decide on the words that would complete each statement.

1. A psychological test is defined as a stick.
2. The investigator who did much in the development of the correlation method was called .
3. The power test has no limit.
4. The good psychological test is both and
5. To determine the reliability of a test the method of is used.
6. When scores earned by a random sampling of subjects are plotted, the curve most often obtained is the curve.
7. Three measures of central tendency are , and .
8. Three measures of dispersion are , and .
9. The -axis is the base-line of any graph.
10. One's score is computed on the basis of the central tendency and scatter values earned by the group.
11. The statement, "She's beautiful but dumb," is an illustration of the erroneous notion of
12. between traits rather than compensation is the rule.
13. The range of  $r$  is from , through , to
14. A chart of one's relative standings on a number of psychological tests is called a .
15. The skewed distribution is characterized by a displaced from the center.
16. A test administered simultaneously to an entire group is called a test.

17. Scores earned on an intelligence test are recorded either in  
or developmental .
18. The first investigator to quantify individual differences was the  
English scientist named .
19. When only a few subjects are studied, the  
is often used for the determination of a measure of central  
tendency.
20. To determine the requirements for a specific position the indus-  
trial psychologist prepares a analysis.

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## CHAPTER FIVE

### *Intelligence*

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#### DEFINITION

Numerous definitions of "intelligence" have been presented from time to time. Although general agreement has not yet been reached the term is frequently defined as the ability of an individual to solve new problems. To be intelligent means, therefore, to be adaptable. "Intelligence" is not a force but rather a characteristic of man's behavior\* in new situations. The term does not mean that the intelligent man is necessarily intellectual. The intellectual man knows a great deal, but at the same time may or may not be more adaptable in new situations than the man less well informed on abstruse topics. The definition also implies that intelligent behavior can be measured only by the performances of men and women on new problems. Psychological "measuring sticks" which gauge this behavior are called intelligence\* tests. These tests consist of numerous problems each of which taps activities used by man for adapting himself to new situations. The activities include remembering, judging, perceiving, imagining, reasoning\*, and thinking.

#### TYPES OF INTELLIGENCE TESTS

The types or varieties of intelligence tests have been classified in several ways.

1. If the tests are grouped on the basis of what they test they are called tests of general\* or abstract intelligence, tests of mechan-

ical\* intelligence, tests of social\* intelligence. By general intelligence is meant the capacity, as measured by tests, to manipulate symbols such as words, numbers, and concepts. This capacity is occasionally called *verbal* capacity or *intelligence* by some. By mechanical\* intelligence is meant the capacity of an individual to solve problems of a concrete, mechanical nature. By social\* intelligence is meant man's capacity to get along with people. Meter sticks in the form of standardized\* psychological tests have been developed to measure the capacity of an individual to adapt to new problems of the three types just described.

2. If the tests are classified on the basis of the way in which numerical scores are obtained such examinations are known as age\* and point\* scales. On the age-scale, credit is given in terms of years and months, for each problem passed by the subject. The conversion of scores into such chronological units is made possible by discovery of the scores earned on these problems by many subjects of various ages. On the point-scale, credit is given in numerical points for each problem successfully completed.

3. If the tests are classified in terms of the ways in which they are administered, we have the group\* and individual\* tests. These tests may be, in turn, classified in terms of the use or non-use of language in their administration. Those in which language is necessary for administration and in which the subject must verbally respond are called *verbal*\* tests. Those for which language is not necessary either for administration or for recording the responses of the subjects are called *non-verbal*\* or performance\* examinations. This means that the person's capacity is inferred, as in any test situation, from what he is able to do, in this instance, without the use of problems involving language.

4. If the tests are classified in terms of a time factor, we have power\* and speed\* tests. On the power test, the subject works as rapidly as he can and there are no time restrictions. On the speed test, definite time limits are set for completion of the work. In every instance, however, the intelligence test is a *psychological* or *mental test*, and is to be looked upon as a standardized\* experiment\* for the determination of one's ability to adjust to new situations.

## HISTORICAL DEVELOPMENT OF TESTS OF GENERAL INTELLIGENCE

Early in the present century Alfred Binet\* (1857-1911) was appointed by the French Government to select those pupils in the elementary schools who were incapable of profiting from attendance at school. To solve the problem, Binet selected grammar school pupils regarded as "good" or "bad" according to the grades assigned to them by their teachers. He then gave these pupils various tasks to perform. The tasks passed by the good and failed by the poor students were then arranged on a scale in terms of the average\* ages of the pupils who passed the questions. Thus, the scale of problems was arranged so that the average five year old could pass all the tests included in the group for five year olds. Any child of this age who passed more items than those of his level was called *above normal\** in intelligence, while the five year old who failed the tests at this level was called *below normal* or *subnormal\**. Binet's\* first scale was thus based upon what most children of a given age were able to do. Credit for passing the questions was given in years and months (the first age-scale).

Binet and his collaborator, Simon, later revised and improved the 1905 age-scale\*. These revisions were published in 1908 and 1911. In 1916 Lewis Terman\* in America revised the 1911 Binet scale by improving the methods (standardization\* procedures) for the determination of the age placements of the tasks. For doing this he used many children at each age level. Terman also found that performances on his new test could be related by a ratio to the chronological (yearly) age of the pupil. If a four year old child passed the tests which average\* six year old children always passed, it followed that the younger child was not only *supernormal\** in his intelligence\* but was also accelerated in his rate of mental development. Terman then made use of the concept of intelligence\* quotient, first suggested by the German psychologist, Stern. This quotient, or I. Q.\*, is a number which represents a *ratio* between mental\* age and chronological\* age. The mental age of the subject was determined by the administration of Terman's Revision of the Binet Scale. The chronological

age was found by asking the subject the date of his birth. The formula for calculating the I. Q. then became mental age divided by chronological age. To avoid decimals, this ratio was multiplied by 100.

$$\text{I. Q.} = \frac{\text{M. A.}}{\text{C. A.}} \times 100$$

Terman's revision in 1916 is known as the Stanford\* Revision of the Binet-Simon\* test, since Terman has been associated with Stanford University, California. The first general\* intelligence test may thus be described as an age\*-scale administered verbally to a single child (individual test). It is also a speed\* test, inasmuch as time limits are set for most of the problems.

Other revisions of the original Binet scales have been made. The most recent (1937) was again made by Terman, assisted by Merrill. This edition consists of two forms or batteries\* of problems, equivalent in difficulty at each age level. Each form is composed of 129 items in contrast with the 90 items of the 1916 revision. Thus, the test may be used with children both younger and older than in the case of the earlier forms. More subjects were used to standardize ("place") items at the correct age level. In 1916, only 900 children of different ages, selected primarily from city areas in California, were studied. For the 1937 revision, over 3,000 children from seventeen different communities located in eleven states were tested to determine where the various problems should be placed in the new age-scale. Children from urban, as well as from rural areas, and from all occupational levels were represented among these 3,000 pupils.

The second major step in the construction of tests to measure general\* intelligence was made by Otis, Yerkes, and others who developed *point-scales\** for administration to groups. Individual tests, such as the Stanford Revisions, require much time to administer. Group\* tests are easier to give and are less expensive to buy. The Army Alpha\* Group Examination appeared in 1917 for use in testing the abilities of men drafted in the World War. The examination consists of 212 items in 8 divisions testing such performances as the following: (1) ability to follow direc-

tions; (2) reasoning; (3) information; (4) word relationships; (5) ability to remember. The performances of the soldiers on this test were used as indicators of ability to learn and to take responsibility. The first Army Alpha Examination has undergone a series of revisions, the most recent of which was carried out in 1940. Along with the verbal\* form of the examination came the non-verbal\* (or performance\*) group test called the Army Beta\* Examination. This test, consisting of seven parts, each presented in pantomime by the examiner, is used today with other non-verbal tests for testing illiterates, children with language deficiencies, and immigrants unable to speak English. These two Army Examinations are combined power and speed tests as well as group scales. The credit earned for passing the items is in numerical points.

In addition to the Army Beta Examination other non-verbal tests requiring the manipulation of objects have been devised. These performance scales are used both in the measurement of the capacities of illiterates to adapt to new problems and in checking the scores earned by literates on previously administered verbal examinations. Among the frequently administered performance tests are the following. The Seguin\* Form Board Examination requires the subject to place wooden geometrical forms into appropriate recesses of a standard form board. The Porteus\* Maze Tests provide standard problems by which the speed and accuracy of a subject can be determined by observing his penciled tracings through a series of increasingly complex labyrinthine patterns. The Pintner-Paterson Performance Scale is a battery\* of form boards, each of which measures the subject's capacity to perform on a number of different standardized\* problems.

The measurement of man's capacity to solve abstract problems originated in the present century with the pioneer work of Binet, Simon, Otis, Terman, Yerkes, Seguin, Porteus, Pintner, Paterson, and others. The result has been the development of standardized experiments which measure what some have termed "general intelligence," or a general all-inclusive capacity to solve ordinary, everyday problems in daily adaptation to the environment.



## THE DEVELOPMENT OF TESTS OF SPECIAL OR CONCRETE INTELLIGENCE

Along with the development of meter sticks for the measurement of general intelligence have come tests for use in specialized fields. These tests, frequently designated as either *aptitude tests* or tests of *concrete (mechanical) intelligence*, measure what one can learn to do, that is, one's capacity for dealing with problems in mechanics, music, art, and related subjects without previous opportunity for training. Inasmuch as individuals differ in their capacities to learn to do as well as in their abilities to do now (involving previous development and practice), tests which aim to measure special capacities make it possible to select those individuals who can benefit most readily from extensive training. These tests of concrete intelligence are classified in the same manner as tests of general intelligence.

Various tests of special capacities have been constructed, first, by those who wished to test the men selected in the World War Draft (1917-1918), and, secondly, by those desirous of guiding human beings in the selection of vocations. Several types are available.

1. Stenquist constructed tests of mechanical\* aptitude for administration to soldiers. This examination, still in use, consists of two parts, the Assembly and the Paper and Pencil divisions. In the first part the subject must re-assemble the separated portions of various mechanical devices (lock, tire pump), and in the second, he must answer questions based on problems of a mechanical and mathematical nature.

2. Meier and Seashore\* developed in 1929 their *Art Judgment Test* which affords a measurement of artistic aptitude\*. The subject's reactions to the items of the test are used to determine whether training in the field of art is desirable.

3. *Seashore's\* Tests of Musical Aptitude* consist of a series of phonograph records which, when played, make it possible for subjects to discriminate pitches, tonal intensities, time, and rhythm among tones and tonal combinations. Scores on this test are compared with norms\* or standards obtained from a large

number of subjects. The final rankings are often used to select students for extensive musical training.

4. Numerous educational aptitude\* tests have been constructed to predict success in school at any level. Many psychologists have aided in the development of the tests, while administrators in colleges and professional schools have developed others. One of the best known is the *Medical Aptitude Examination*. This scale measures the training of the pre-medical student as well as his ability to use numerous facts, related to his profession, in the solution of original problems. The test scores correlate\* fairly well with the degree of success in medical college and with performances of internes after graduation. The test, however, is an achievement\* test to the degree that it measures the recognition and recall of subject matter learned in preparatory courses. The *Jensen Educational Aptitude Test* is occasionally used for the selection of potentially good teachers. Each of these types of aptitude tests is looked upon as a measure of special capacity which may or may not be possessed to the same extent by any two individuals.

### THE DEVELOPMENT OF TESTS OF SOCIAL INTELLIGENCE\*

Standardized procedures for the reliable and valid measurement of an individual's capacity to perform in a wide variety of social situations have not been widely developed. For this the case\* history and the questionnaire\* methods are more often used by the clinical psychologist. One exception is the George Washington University Test of Social Intelligence devised under the direction of Moss in 1925. This examination is composed of problem situations to each of which the subject responds, for example, with the most socially accepted thing to do. In other instances the subject's ability to remember names and faces and his sense of humor are quantified. Scores earned on these tests correlate well with judged sociability as determined by rating\* scales.

### THEORIES OF INTELLIGENT ACTION

Psychologists and physiologists have long been concerned with the nature of man's capacity for intelligent performance on

standardized tasks. Historically, two groups of theories, the strictly psychological and the strictly physiological, have been formulated from time to time to account for "intelligence." Representatives of each of these two groups follow. Among the theories formulated by psychologists are the following:

1. *The Unitary Theory.* This theory assumes man to be equally good in adjusting to different problems of equal difficulty. If this conception were found to be correct, it would mean that man could succeed in any one of many lines of work provided equal training and interest existed. Man is assumed by those who accept this theory to be equally proficient in all situations. Obviously not all men would be able to master some of the problems which people with more ability could. Special or concrete intelligence, in terms of this theory, is explained as due to much practice and marked interests. Recent studies of intelligence test scores by means of factor\* analyses do not support this theory, inasmuch as the coefficients\* of correlation between various types of tests do not approach plus 1.0. This perfect correlation would be expected if the theory were to be supported.

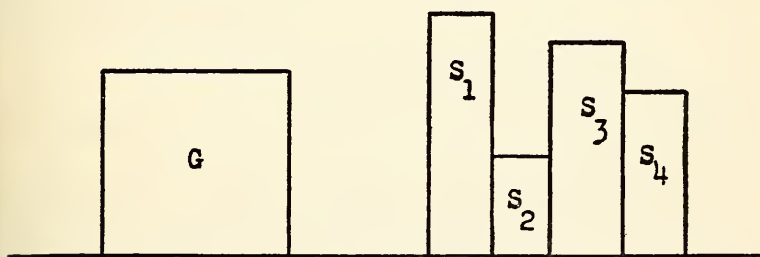


Fig. 17. Schematic representation of Spearman's Theory of Mental Ability. General plus special abilities are equivalent to mental ability.

2. *The Two Factor Theory.* Spearman (1927) has maintained that man's ability to adjust intelligently is determined by general\* (g) and special (s) abilities or factors. The amount of "g" varies from one subject to another, but remains constant for each person. The "s" abilities are numerous and vary in their composition and complexities from one person to another as well as

within the same individual. "G" is a common element in all tests. "S" factors, when present in varying amounts, will contribute to the results if the nature of the test affords an opportunity. Mental ability is assumed by Spearman to consist of these two factors, "g" and "s."

3. *Group Factor Theory*. By factor\* analyses, Thurstone\* (1935) has shown in extensive studies of intelligence test scores that intelligence includes at least seven clusters of *primary* or basic *abilities*. Each primary ability functions in tests which tap this ability, such as the ability to use numbers. All scores from different "number tests" will correlate\* with each other and compose a cluster. All scores on "number tests" will not correlate with scores made by the same subjects on distinctly different tests. These seven clusters of primary abilities give us the most recent answer to what general intelligence is. Thurstone says it is a series of clusters of independent primary abilities. These clusters are: (1) number ability; (2) verbal ability; (3) ability to remember; (4) ability to visualize in spatial terms; (5) perceptual speed; (6) induction\*; (7) deduction\*. Man may possess a large amount of one or more capacities and less of others. One's score on an intelligence test will, accordingly, depend upon the degrees to which these primary abilities are possessed as well as upon the composition of the test itself.

Representative *physiological* and *neurological theories* to account for intelligent action follow.

1. *Kappers' Theory of Neurobiotaxis\** (1917). The growth and polarity of axone and dendrites are to be accounted for in terms of an electric field in which the developing nerve cells are located. This factor of neurone\* growth toward areas of increased stimulation, first proposed by the neuro-anatomist, C. U. A. Kappers, has been used by Holt (1931)<sup>1</sup> to account for intelligent action. Intelligence represents for him the capacity for the continued development of new dendrite\* and axone\* relationships. New neural connections in this way appear and underlie one's increased capacity to perform on standardized tests.

<sup>1</sup> E. B. Holt, *Animal Drive and the Learning Process*. New York: Henry Holt, 1931.



2. *Lashley's\* Theory of Equipotentiality\** (1929).<sup>2</sup> To test the old and often accepted notion that learning and intelligent action could be accounted for in terms of *decreased resistance\** of the synapse\* to the passage of a nerve excitation (see Chapter 2), Lashley studied the effects of cortical operations upon the capacities of animals to learn, to retain, and, in general, to adapt to problem situations. His evidence indicates that the "learning process and retention of habits are not dependent upon any finely localized structural changes within the cerebral cortex. The results are incompatible with theories of learning by changes in synaptic structure, or with any theories which assume that particular neural integrations are dependent upon definite anatomical paths specialized for them. Integration cannot be expressed in terms of connections between specific neurons."<sup>3</sup> Lashley goes on to point out that "the contribution of the different parts of the specialized area or of the whole cortex, is qualitatively the same . . . a non-specialized dynamic function of the tissue (of the cortex) as a whole" exists. Intelligent action is thus considered to be a byproduct of the general, dynamic organization of the entire human cerebrum\*.

### THE GROWTH OF INTELLIGENCE\*

If intelligence tests are administered year after year to children, the scores show that the subjects, as they grow older, are able to pass problems of greater difficulty. This fact implies that mental development is going on. Mental development, however, does not continue, according to Terman\*, beyond the age of 16 years. Thus, for a person over 16 the I. Q.\* would be determined on the Terman age-scale\* (1916 Revision) by dividing the Mental\* Age by 16 rather than by the chronological age of the person tested. Some investigators question this value, and offer 13, 14, 15, and even 18 or 22 as better values. The fact that one's ability to solve new problems ceases to develop beyond a certain age does not mean that one is unable to go on learning. It merely means

<sup>2</sup> Quotation reprinted with permission of the University of Chicago Press from Lashley, *Brain Mechanisms and Intelligence*, 1929, p. 176.

<sup>3</sup> K. S. Lashley, *Ibid.*, page 176.



that one's level of intelligent action, his *altitude* so to speak, has been reached.

When intelligence test scores, obtained by testing and retesting groups of children at various ages, have been arranged on a graph\*, we have a curve of mental development. In Figure 18 note that mental development for those children of different levels of ability tapers off at approximately the same time. Study of these curves indicates that development is rapid at first, followed by a decreased rate. Accordingly, the curves are said to be *negatively accelerated*. The gains each year, measured in terms

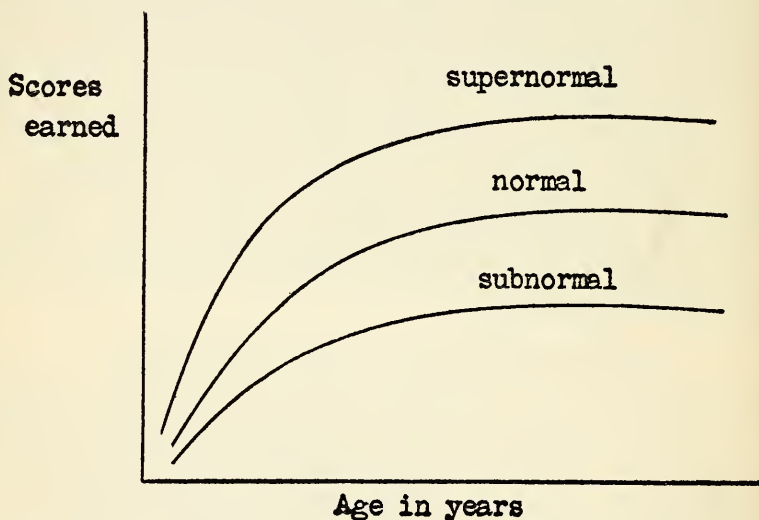


Fig. 18. Development of general intelligence as shown by plotting raw scores earned by children retested from year to year. The children are of different levels of ability. Diagrammatic only.

of the items passed, are relatively greater at first and are followed by the passing of relatively fewer additional items until maturity\* is reached (sixteen years, according to Terman\*). Growth curves for children of different levels of ability indicate for each child a rate of mental development which remains relatively constant as shown by comparisons with other children of the same chron-

ological age. The child who is slow in development at five years will be slow at ten. The child at five who shows a growth rate greater than that of the average five year old will also exhibit an accelerated rate at ten. The rule is that, other factors being constant, the superior remain superior and the inferior remain inferior.

### IS THE I. Q.\* CONSTANT?

Until quite recently most students were assured that the I. Q. was the same from year to year. Slight differences of 5 to 7 points on retests were accounted for by reference to errors in measurement or other uncontrolled variables. Experimenters at the University of Iowa (Wellman, Stoddard, and others) have reported, however, that pre-school children made permanent gains in their intelligence quotients after placement in a modern nursery school. Control\* children of equal I. Q. at the beginning of the study were not enrolled in the nursery school. A year later these children showed no gains in their I. Q. ratings. Likewise, children in orphanages, after prolonged training in a nursery school, showed increases in their retest scores. Some of these children were raised from the moron\* class to that of the normal\*. Feeble-minded\* children have been reported to show shifts in I. Q. scores after having been cared for by high grade moron girls. Stoddard and Wellman hold, therefore, that a stimulating environment may raise intelligence quotients. Critics of these Iowa studies of the "changing I. Q." have explained the results in terms of (1) the unreliability of scores earned by infants and very young children; (2) accidental coaching for the tests; (3) unintentional misinterpretations of the data collected. Inasmuch as no conclusion can be reached at this time on this extremely important practical and social question, the reader should suspend judgment on the problem. The real question is whether the I. Q. is constant or is labile. If it is labile, stimulating environmental situations over a long period of time might be expected to raise the I. Q. ratings. With the accumulation of more evidence an answer will undoubtedly be forthcoming.

## THE DISTRIBUTION OF INTELLIGENCE TEST SCORES

When large numbers of subjects of the same age and with similar environmental backgrounds are tested and the scores are plotted, the normal\* distribution curve is obtained. This means that people differ only in degree, in their abilities to solve problems and to adapt to their environments in an intelligent manner.

In terms of the I. Q. scores the following distribution of general\* intelligence is found in a random\* sampling of any population to which the test can be administered.

<i>I. Q. range</i>	<i>Percentage</i>	<i>Designation</i>
0- 70	1	Feeble-minded
70- 80	5	Borderline
80- 90	15	Backward
90-110	58	Normal
110-120	15	Superior
120-130	5	Very superior
130 plus	1	Genius*

\*Some writers use the score 140 to designate the genius. In this case the percentage is less than 1%.

A similar normal distribution is yielded from point values by the administration of the Army Alpha\* Examination to a large unselected group of adult subjects.

## THE TWO EXTREMES OF THE SCALE

Feeble-mindedness\* is a social and legal term indicating that a given individual is incapable of making his own way (economically, educationally, and socially) because of limited mental ability. The medical profession designates these individuals as *aments* (cases of *amentia*\*). This term indicates that the feeble-minded person has been defective since birth in contrast with *dements*, (cases of *dementia*\*) who were once normal in intelligence but are so no longer, because of the effects of drugs and parasites which have destroyed brain\* tissue.

Aments are of three groups. Morons\* are those of any age whose I. Q. ratings range from 50 to about 70. Imbeciles\* are

individuals whose I. Q. scores range from 20 or 25 to about 50. Idiots\* are persons of any age whose intelligence quotients range from zero to about 20. The adult idiot and imbecile are charges of society and cannot be trained to perform remunerative tasks. The "high grade" adult moron, on the contrary, may be trained to take his place in society, doing routine tasks which frequently bore others of higher intelligence. Morons, however, generally require supervision.

Individuals with I. Q. scores of over 130 are considered geniuses\*. They are able to pass more difficult intelligence test problems and are, therefore, considered better able to adjust to new situations. Their contributions to society cannot be overestimated. Extended experimental studies based on more than a thousand genius children in California by Terman\* have indicated once more the incorrectness of the oft-repeated doctrine of compensation\*. Genius children, instead of being weak and sickly, as this doctrine assumes them to be, are found to be superior in physical and mental health to children of average\* intelligence. Genius children have a wider range of interests, play more games, and read more than the non-genius children. They come, Terman finds, predominantly from professional and semi-professional homes. Hollingworth's\* results have supported Terman's findings by indicating that genius children are taller and healthier than the less gifted.

### SELECTED RESULTS OF INTELLIGENCE- TESTING PROGRAMS

1. *Race.* General intelligence tests given to members of different races have indicated that the Negro, the Mexican, and the Indian are inferior on speed tests to the native white. The Jewish, on the other hand, are frequently found superior by a few points to the native American. Immigrants from Southern Europe are reported inferior to those from Northern Europe. If these facts are interpreted as evidence in favor of an inherent intellectual superiority of some races, this interpretation is open to criticism since test items based upon one culture and administered to peoples of another culture may lead to false conclusions.

These racial differences may, therefore, indicate only the role of culture in the derivation of intelligence test scores.

2. *Sex*. At one time men were considered superior in ability to women because the average\* male brain has been found to be heavier than that of the female. Repeated administration of tests of intelligence to members of the two sexes has not supported this notion of male superiority. Little real difference, if any, exists. Girls generally do better on memory\* and language problems, while boys excel on reasoning\* and natural science questions.

3. *Occupations*. Members of the professions rank first, skilled and non-professional workers second, and the unskilled laborers last on tests of abstract or general\* intelligence.

4. *Location*. Urban children usually score higher on general intelligence tests than do rural children. Some consider this fact to indicate the role of environment rather than the role of an hereditary factor.

5. *Crime and Delinquency*. Criminals and juvenile delinquents are low normal\* (80-90) on the average in I. Q. ratings. They are not, therefore, all feeble-minded\* as some have assumed. While only one percent of the population is amented\*, from 10 to 20 times this percent of delinquents are feeble-minded. Feeble-mindedness is thus one of the causes of crime and delinquency. Criminal and delinquent acts are related, likewise, to the I. Q. of the offender. The more intelligent criminals commit fraud crimes rather than assault and battery.

As preventive measures for control of asocial behavior (criminality and delinquency) two social movements are often encountered. The euthenics\* program aims to improve the human race by improving the environment. Slum clearance projects are illustrative. The studies by Wellman and Stoddard on the changes in the I.Q. as a result of stimulating environments are also illustrative. The eugenics\* program aims to serve society by improving the heredities of those yet unborn. This program would entail, if put into effect, *sterilization* of those judged to be biologically unfit to reproduce. It would entail also the regulation of marriages of those judged to possess superior hereditary backgrounds. In the last analysis the success of the eugenics program would rest upon the available evidence of the direct inheritance of specific traits\* by man.



## FACTORS OPERATIVE IN THE DEVELOPMENT OF INTELLIGENCE

1. *Heredity\**. The fact that the genes\* and the chromosomes\* contribute to the development of man's ability to use past experience in the solution of new problems is clearly indicated by intelligence test scores earned by children in the same families. The coefficients\* of correlation included in the following table become progressively higher as the blood relationship increases.

<i>Relationship</i>	<i>Coefficient</i>
Unrelated children	.00
Cousins	.25
Siblings	.50
Fraternal twins	.60
Identical twins	.90

Heredity is said to set the limits of mental development. Environmental conditions make this developmental unfolding possible. Heredity, however, cannot alone guarantee normal\* development under markedly abnormal environmental conditions. Studies of "jungle children," discovered after many years of life in the wilds, support this statement.

2. *Environment*. Several lines of evidence indicate that the development of man's ability to act intelligently in new situations depends upon environmental conditions. Tests given to young children living in backward communities have yielded intelligence test scores around 100. Older children in the same communities have tested considerably below normal\*. The absence of a stimulating environment is thought by some to be the cause for the progressive dullness of these children with advancing age. Second, children who are blind or deaf are found definitely handicapped in their abilities to deal with new situations by virtue of their limited auditory and visual sensory capacities. Third, a definite relationship exists between the socio-economic background of the child and his score on an intelligence test. Children in orphanages make a larger number of scores below 70 than do public school children. Children in private schools make higher scores than those enrolled in public educational institutions. Fourth, foster children adopted into highly superior homes at

tender ages show gains in test scores after a period of years. These and other evidences show clearly that education, cultural advantages, and other environmental factors combine with the hereditary in the determination of intelligent action.

### PRACTICAL APPLICATIONS OF INTELLIGENCE-TESTING PROGRAMS

1. *In education.* With the rapid development of standardized\* tests for the measurement of general\* intelligence, numerous modifications of the earlier examinations have been devised for use in school systems. These newer batteries\* are administered to measure the capacities of pupils at various stages in the educational program. For children in the lower grades non-verbal\* or performance\* tests are given to each pupil as an individual test. In the more advanced elementary grades groups of pupils are often given verbal speed tests similar in form to the Army Alpha\* Examination. The Kuhlmann-Anderson\* and the Henmon-Nelson tests are illustrative types of those available. At the high school and college level the Otis Self-Administering Test of Mental Ability, the American Council on Education Psychological Examination, and others are frequently used. Numerous colleges and universities have, in addition, devised entrance examinations to fit their respective needs. Throughout the educational system, then, the administration of intelligence tests provides the educator with information concerning a student's capacity to profit from instruction. The testing program also provides one important criterion, utilized along with a number of other equally important factors, for the placement of pupils in more homogeneous\* groups. Even though the psychologist and the educator realize the need for facts additional to those obtained by the measurement of general intelligence in the evaluation of the pupil's personality\*, these tests have yielded significant findings. Scores earned, for example, on standardized\* tests are used today to predict the probable degree of success in school. They are used in many instances as a basis for the selection of potentially good students at the college level.

A tool in general use in the analysis of scores earned by large numbers of students in grade school, high school, and college is

statistics\*. To interpret the scores collected from the administration of intelligence tests, norms\* or standards of degree of intelligence must be established. The norms are calculated, first, by arranging the scores in order of magnitude from low to high. This distribution of scores earned on the standardized experiment is then divided into smaller units each of which indicates the relative position of the scores in the entire distribution. These smaller units may be in the form of quartiles\*, deciles, or percentiles\*. Just as the median divides the scores earned into two groups, so the quartile\* divides the distribution into four groups. The 25th percentile, or first quartile, is that point in the distribution of scores below which lie 25 percent of the scores. The 75th percentile, or third quartile, is that point in the array of scores below which lie 75 percent of the scores earned on the test. The upper limit of the second quartile in the symmetrical\* curve of distribution is equivalent to the median\*, and below this limit lie 50 percent of the measures. If the quartile placement is given it is, therefore, possible for the student to place his own score in the appropriate group. He then knows what percentage of the original standardizing group earned scores above or below his score on the intelligence test.

These norms\*, established upon the performances of the standardizing group, may be expressed in percentiles\*. Instead of counting off 25 percent of the scores from the extreme of the distribution, the experimenter may count off in groups of 10 percent values. The resulting groups of scores are now arranged in deciles\*. A score placed in the 10th percentile, or the first decile, means that 10 percent of the scores lie below this point on the scale of earned measures. The decile values divide the scores into groups of 10. The percentile values divide the scores into units of 1. A percentile value of 90 (decile value of nine) means that 90 percent of the subjects earned lower scores than those in this group. If a raw\* score falls in the 97th percentile only three percent are known to have exceeded the performance of the student earning this high percentile rank. The use of the quartile, decile, and percentile ranks makes easy an immediate interpretation of any score earned on a specific test. Raw scores must be carefully arranged in groups and converted into values repre-

sentative of the entire group. Norms\*, used as standards to give meaning to mental\* age and point\* scale values, are often expressed in terms of the quartile, the decile, or the percentile. At a glance an earned score can be readily identified with those who have done better or worse on the standardized experiment.

2. *In vocational guidance.* The fact that those of higher general\* intelligence are more successful in certain occupations than others of less ability is used, along with other equally important measures, to aid students in selecting a life work. A series of intelligence tests, including tests of general, mechanical, and social intelligence, are administered to determine a person's general and special capacities. After these scores have been studied a *profile\** of intelligent action is constructed. The person then notes those specific areas in which his performance scores are high. The selection of courses to study in high school and college and the vocation to pursue are thereby facilitated.

3. *In industry.* Men differ from one another in intelligence just as they differ in height and weight. Business and industrial executives have learned that an employee can be too intelligent as well as not sufficiently intelligent for a job. In the former case rapid turnover among the workers results, and in the latter, inferior work and accidents may prevail. In the selection of employees the job is first analyzed carefully. An optimal\* intelligence score is determined by examining those already successful on the job. These intelligence tests, second, are administered to applicants for vacancies in the plant. Tests of concrete (mechanical) intelligence are often administered in addition to tests of general intelligence. The job profile\* and the applicant profile can then be used as a sound basis for the selection of employees.

### HOW TO USE TESTS OF INTELLIGENCE\*

The importance of intelligence tests in education, vocational guidance, and industry is conceded. A word of caution in the interpretation of the scores earned on these tests, however, is needed.

*First*, a single score earned on any standardized\* test cannot be used as the best single index of human capacity. Nor is the single



score the sole index of the effective personality\*. Additional examinations, each testing man's capacity to solve other types of standardized tasks, are recommended. Several indicators are, therefore, more helpful in the prediction and control of human action than a single index. The *behavior sample*, accordingly, is often used to counteract the tendency to interpret a single score earned on an intelligence test as the sole indicator of what a person can or cannot do. By this technique the everyday behavior of a person, usually a child or an adolescent, is observed by trained investigators. These periods of observation often yield data obtained by no other method. The findings aid in the interpretation of scores already earned on a series of standardized tests.

*Second*, caution is shown when age-scales\* of intelligence are administered to young children, infants, and adults. This practice does not always yield results sufficiently consistent for purposes of prediction. Indeed, Gesell,<sup>4</sup> Goodenough,<sup>5</sup> and others have encountered these difficulties in their studies of infant intelligence. At the other extreme, age-scales have not yet been generally adapted for administration to older, more mature subjects. Wechsler<sup>6</sup> has been developing a scale of this type for the measurement of intelligent performance among adults. Until further evidence is available, reliable and valid age-scales can be administered most wisely to subjects between ages of three and eighteen years.

*Third*, our interpretations of test results should include a consideration of how much weight should be given in the final score to each of the tasks which compose the intelligence test. Obviously any test of performance must contain problems or standardized test situations which range, for the average\* person, from the very easy to the very difficult. These tasks must be arranged by the psychologists constructing the test so that appropriate weights or score values can be assigned to each task.

<sup>4</sup> A. Gesell, and others, *Biographies of Child Development*. New York: Hoeber, 1939. Pp. 328.

<sup>5</sup> F. Goodenough, *Developmental Psychology*. New York: Appleton-Century, 1934. Pp. 293-323.

<sup>6</sup> Wechsler, D., *The Measurement of Adult Intelligence*. Baltimore: Williams & Wilkins, 1939. Pp. 229.



Thurstone<sup>7</sup> and others have been making this painstaking analysis of test items. Until the relative importance of each task can be expressed numerically either in developmental months or points, jumping to conclusions concerning one's score on a single problem included in a test of intelligence is to be deplored. Only with continued analysis can the psychologist tell us how much weight to give each task.

Tests of intelligence, like hammers and saws, are valuable tools. Each tool, however, has its respective sphere of application. Intelligence tests must be used appropriately. Just as a yardstick is used to measure the length of a room, so a number of meter sticks of intelligent action are used to gauge the degree of man's capacity to adjust to his environment.

### TEST QUESTIONS

A. *True-False Statements.* Study each statement and decide as to its truth or falsity.

1. Terman constructed the first age-scale of general intelligence.
2. The I. Q. is a ratio between mental and chronological ages.
3. The Binet-Simon intelligence tests are point scales.
4. Tests of general intelligence tap those activities which man uses in adjusting to new situations.
5. Intelligence tests are standardized experiments.
6. No measuring instrument known as an I. Q. test exists.
7. Psychologists at the University of Iowa have questioned the constancy of the I. Q.
8. Native ability alone is measured by any test of general intelligence.
9. In a symmetrical distribution the second quartile point and the median coincide.
10. Scores earned on age-scales and on point scales can be interpreted in terms of percentile ranks.
11. Identical twins are less similar in their intelligence quotients than siblings.
12. The Medical Aptitude Examination measures solely concrete intelligence.

<sup>7</sup> J. P. Guilford, *Psychometric Methods*. New York: McGraw-Hill, 1936. Pp. 437-449.

13. For Spearman mechanical aptitude is an illustration of the "s" factor.
14. Terman holds that the altitude of one's ability to adjust is reached at eighteen years.
15. The 1937 Revision of the Stanford Examination is more adequately standardized than was the 1916 revision.
16. About six percent of the population in the United States is amented.
17. Girls are generally inferior to boys on tests of intelligence.
18. Certain writers hold that cultural differences may explain the racial differences indicated by intelligence test scores.
19. Heredity alone is responsible for the development of intelligent behavior.
20. Growth curves of intelligent behavior are negatively accelerated.
21. Amentia is the chief cause of juvenile delinquency.
22. Intelligence and intellectuality are synonymous terms.
23. The Seguin Form Board is an illustration of a non-verbal or performance examination.
24. According to the unitary theory of intelligence man would do equally well in all kinds of problems.
25. According to Lashley no one cerebral area is responsible for intelligent action.
26. The subnormal child of ten will be subnormal at fifteen.
27. An employee cannot be too intelligent for his position.
28. By administering a series of intelligence test batteries a profile of intelligent behavior can be constructed.
29. All dements are aments.
30. The Army Alpha Examination is an age-scale.

B. *Completion Statements.* Read the incomplete statements and decide on the words that would complete each statement.

1. In the construction of an intelligence test the determination of the proper placement of a task in the test is called the  
procedure.
2. Intelligence test scores, when plotted in a frequency distribution, yield a curve with a single .
3. The Army Alpha Examination is scored in .

The Stanford Revision of the Binet-Simon Examination is scored in

4. Genius children are usually physically  
than the less gifted children.
5. The examination used during the World War to measure the  
intelligence of the illiterate is called the
6. John's M. A. is ten. His C. A. is fifteen. His I. Q. is  
. He is a child.
7. Mary's I. Q. is 160. Her C. A. is twelve. Her M. A. is
8. The erroneous notion that the gifted child is physically weak is  
called the of
9. Standardized examinations have been constructed for the meas-  
urement of three types of intelligence, namely (1)  
, (2), and  
(3)
10. Modern slum clearance programs illustrate the  
program in action.
11. Ann's I. Q. is 108. Her M. A. is 9. Her C. A. is
12. Race improvement by sterilization is one aim of the  
movement.
13. Intelligence tests are available for administration to groups or  
to
14. The first to suggest the use of the I. Q. as a ratio was the German  
child psychologist
15. A well known test for the measurement of aptitude in music was  
devised by in 1919.
16. The primary abilities of man are, according to Thurstone, as  
follows: (1), (2),  
(3), (4),  
(5), (6),  
(7)
17. The intelligence quotient of the moron may fall between  
and
18. Approximately percent of the population is classified  
as genius in intelligence.

19. The success of the eugenics movement depends primarily upon proof that particular traits deemed undesirable are  
from one generation to the next.
20. Henry's score on the Army Alpha Examination is in the 56th percentile. This means that \_\_\_\_\_ percent of the people taking this test made lower scores than he.
21. Mary's score on the Moss Test of Social Intelligence is in the first percentile. This means that \_\_\_\_\_ percent of the students taking this examination made higher scores than she.

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## CHAPTER SIX

### *Motivation and Adjustment*

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#### THE "WHY PROBLEM"

THE EXISTENCE OF THE SCIENCE\* OF PSYCHOLOGY\* is evidence of man's curiosity about himself and his fellow men. Its existence indicates, indeed, an interest not only in *what* man does, but also in *why* he behaves as he does. The answer to this *why problem* is basically derived from studies on the *drives, motives, and incentives* of man and other animals. To this problem we now turn.

#### APPROACHES USED IN ANSWERING THE "WHY" PROBLEM"

Theories offered to account for why man does as he does can be grouped into those designated as early and modern.

First, in the pre-scientific periods, men believed in the doctrine of animism\*. They believed they behaved as they did because of hidden "spirits" resident within themselves. To illustrate, one early treatment for insanity\* was that of bleeding the patient to rid him of evil spirits. This notion of animism was also used to explain the falling of stones, the phenomena of the stars, and the coming of electrical storms. All objects, animate and inanimate, were held to be inhabited and controlled by these ruling spirits, some good and some bad. This hypothesis has been rejected.

Second, in the present century, several theories have been formulated to account not only for why man behaves as he does

but also to account for what is meant by personality. Selected interpretations follow.

1. *The psychoanalytic theory of motivation* (psychoanalysis\*). Sigmund Freud\* (1856-1939), an Austrian physician, developed a much discussed theory to account for the behavior of patients deemed by him to be suffering from psychotic\* and psychoneurotic conditions. This theory has been broadened to explain behavioral phenomena more normal\* in nature. Although his conceptions have not been completely accepted by many experimental psychologists in America, Freud's influence upon clinical and abnormal\* psychology, sociology, anthropology, and psychiatry\* has been great. A brief review of the basic psychoanalytic tenets as related to motivation\* and to personality\* follows.

First, Freud\* has formulated the concept of a single, innate, all-inclusive psychic energy called the libido\*. Its nature and the channels through which the energy flows within the nervous system partially determine the nature of man's wants, actions, and personality. The libido, functioning in accordance with the *pleasure principle*, is directed in its flow toward pleasurable experiences and away from painful ones. The chief function of the libido is thus to direct human thought and action toward the satisfaction of what Freud calls three inherited or instinctive tendencies. This psychic energy, as a psychoanalytic concept, must, therefore, be broadly interpreted as the single energizing factor in human behavior. Many writers have none the less erroneously interpreted the concept of the libido to mean the sex drive.

Second, the *reality principle* functions in opposition to the pleasure principle. The child and the adult cannot hope always to achieve immediate satisfaction (pleasure) for their ever increasing needs. The complexity of society prohibits, therefore, the complete and autonomous functioning of the libido's pleasure principle. Indeed, man must learn to postpone this achievement of pleasure in accordance with the dictates of society. He must even endure pain occasionally. The satisfaction of many of man's needs must, therefore, be held in abeyance until they can be satisfied in socially acceptable ways. Among the most difficult of human impulses to hold in abeyance for future satisfaction,

according to Freud, is the sexual. For this reason numerous instances can be found in which the pleasure principle has won out at the expense of the reality principle. Behavior abnormalities result. A psychoneurotic condition may develop as a consequence of long continued frustration\* and conflict\*, essentially sexual in nature. Freud does not, however, maintain that all psychoneurotic conditions are the byproducts of sexual maladjustments.

Third, three innate\* drives or impulses to action are assumed in psychoanalytic theory. Freud calls them the *sexual*, the *ego*\*, and the *hostile* or *aggressive* instincts\*. These three inherited drives function according to the natures of three organized, conceptual systems designated as the *Id*\*, *Ego*\*, and *Super-Ego*\*. The *Id* represents man's primitive, animal-like impulses, and is governed by the pleasure principle. The *Id* consists of uncontrolled impulses for sexual gratification, for food, and for aggressive action. The *Ego*, on the other hand, symbolizes the ways by which man satisfies intelligently and consciously (for the most part) his instinctive needs in accordance with the demands of society. The *Ego* is thus governed by the reality principle. The *Super-Ego* stands for those relatively unconscious and habitual traits acquired early by learning to do what society wants. The *Super-Ego* is our conscience.

Freud thus looks upon human behavior as basically directed by one energizing force, the libido. This force directs man toward the satisfaction of innate sexual, ego, and aggressive impulses to act. He considers the *Ego* and the *Super-Ego* as byproducts of learning and maturation. Their natures represent along with the characteristics of the *Id* the personality\* of the individual at the moment. Abnormalities in human behavior occur when the functions of the *Ego* and the *Super-Ego* are interfered with or when they do not develop normally. Under these conditions the *Id* and the pleasure principle are more dominant than normally in directing human action.

2. *The Will-to-power theory.* Alfred Adler\* (1870-1937), at one time a student of Freud, has assumed the existence of a single force directing and sustaining man's energies toward the achievement of power and superiority. This "will-to-power"\*, when thwarted either by real or imagined obstacles during childhood\*

and adolescence\*, is the cause of inferiority\* complexes. Direct and indirect methods of compensation\* are believed by Adler to represent nothing more than ways by which man may attempt to achieve his single purpose in life—that of superiority\*. Although the “will-to-power” is no longer generally accepted as the single energizing factor in human behavior, Adler’s emphasis has resulted in better methods of rearing children. In addition, modern evidence indicates that the “will-to-power” is not an inherited tendency.

3. *Lewin’s theory of tensions.* The Gestalt\* psychologist Kurt Lewin\* accounts for human motivation\* and personality\* development in terms of *needs, tensions, valences, and barriers*. His theory, modeled upon recent approaches utilized in theoretical physics, can be described as follows. The individual, possessing different tissue needs which are essentially physiological in nature, experiences tension in the absence of immediate satisfaction of the internally aroused tissue demands. Tension is synonymous with stress and strain within the organism. These experienced stresses or tensions are reduced, and organic as well as psychological equilibrium is attained, when the needs are satisfied. Tensions are also induced when one observes an environmental object which possesses a *demand value* or *valence* for the person at the moment. The actions of a child upon first seeing and then reaching for a stick of candy are illustrative. Inasmuch as internal needs influence the demand values of objects, and vice versa, a *dynamic* relationship exists between needs, tensions, and valences. The presence, in addition, of barriers or obstacles between the organism in need and the object with a high valence value gives rise to tension-inducing experiences. For Lewin, the frequency and the nature of the barriers to goal-directed behavior are important determiners of personality traits.

These three theories offered to account for the *why* of human behavior are illustrative of a larger number. By way of the experimental laboratory the psychological study of motivation has been further advanced. To this laboratory approach we shall now turn.

Lewin has developed recently the *topological method* for investigating problems pertinent to this theory. *Topology*, essentially a branch of mathematics, is used as a procedure by which heretofore unquantified behavior variables are measured by other than



the more traditional measuring instruments. The strength of a student's drive to achieve membership in a club, to illustrate, may be measured by counting the number of activities exhibited in the effort to achieve this goal. This number serves as an index of the strength of the drive. *Topological psychology* aims, therefore, to study experimentally Lewin's theoretical conception of motivation and personality.

4. *The Stimulus-Response Approach.* This approach to the study of the "why problem" holds that the psychology of motivation is the scientific study of those stimulating conditions which arouse, sustain, and direct human activity toward goals for the satisfaction of the needs of the organism. The psychology of motivation is thus the study of those energizing and intensifying factors which arouse man to adjust to his wants. An adequate stimulus, accordingly, serves as a precipitating factor in the determination of our behavior at a given time. The relation between the stimulus and the arousing, sustaining, and directing of one's activities thus is an important question. Inasmuch as sensory stimuli can be proved to exert an effect upon the human organism, it is clear that those stimuli which persist, or whose after-effects persist, will arouse and sustain action. Persistent stimuli become the clay out of which the fundamental drives of life are moulded.

*The classification of drives.* In order to clarify our knowledge of these stimulating situations, stimuli which arouse, sustain, and direct human behavior are grouped into different classes on the basis of certain characteristics possessed in common by each class. The classification most frequently used is that of the *first-order*, or *physiological*, and the *second-order*, or *social*, drives. Internal stimuli, operative at birth and, at first, giving rise to diffuse, restless activity, and, later, to more co-ordinated, specialized acts as a consequence of the processes of maturation and learning, are called drives of the first-order. This group includes those stimuli which activate the person at any age to (1) eat when hungry; (2) drink when thirsty; (3) rest and sleep when tired or exhausted; (4) change bodily position when too cold or too warm; (5) avoid injury. Internal stimuli induced by emotional reactions also serve as drives to action. Anger, fear, and sexual emotions, as well as other emotional reactions, energize



and direct human action. On the basis of these internal stimuli man comes to terms with the demands of his inner environment. W. B. Cannon, the American physiologist, designates this process of physiological adjustment to first-order drives as *homeostasis*. By this he means that man and other animals tend to maintain optimal living conditions by adjusting to their immediate internally aroused needs.

Stimuli from the social environment, and hence primarily external to the organism, which arouse, sustain, and direct human activity are called second-order drives, or, simply, *motives*. These motives may be looked upon as essentially modified first-order drives in the sense that the goals involved are acquired, and, as such, are much less direct than the more immediate goals of the first-order drives. Through the interacting roles of maturation and learning the first-order drives become associated with new ways of satisfying man's wants in an expanding outer environment. Hence, adults exhibit numerous second-order drives which are the by-products of learning. Man is thus, to illustrate, motivated to learn a trade, to marry, to vote in the local and national elections. Each of these second-order drives represents, therefore, an elaboration of one or more of the first-order drives which can now be satisfied by new methods of adjustment acquired as a result of the processes of maturation and learning. The acquisition of new methods of adjustment to one's wants is related to the presence of stimulus-objects, called *incentives*, in the environment. These incentives serve to direct our behavior toward particular goals. Thus, the box of candy on the table, as a stimulus-object, serves as a guide to the hostess in her arranging a pleasant evening for the guests (her goal). Second-order drives *to master* (overcoming obstacles), *to gain social approval*, *to conform* (avoiding criticism and blame), and *to feel socially and economically secure* may be observed daily in the responses of those about us. Drives are thus, in the first instance, classified on the basis of their origins. First-order drives are innate and physiological; second-order drives, or motives, are learned and social.

Second, drives may be classified in terms of our *awareness* of

consciousness of them as agencies directing our behavior. With the elaboration of drives into motives, man frequently shows that he is aware of a variety of goals which will satisfy his experienced desires, such as hunger and thirst. This awareness is often stated symbolically in the form of words and gestures. "I am hungry" represents the conscious aspect of the drive. Indeed, the end-result, the goal, may, as a consequence of previous learnings, be anticipated, and the person may show *purposive behavior*. Purposive responses are none other than those for which man knows the means of satisfaction or recognizes the significance of the incentive. "I am hungry" leads the individual to plan a raid on the ice-box for the satisfaction of the subsistence drive, illustrating for us a purposeful act. Purpose is made explicit by knowledge of both goals and appropriate incentives. In those instances in which we are unaware of the drives and incentives which direct our reactions the psychologists speak of *unconscious motivation* rather than of purpose or *conscious motivation*. Evidence indicates that all learned behavior is motivated. If man is unaware of the motives, the psychologist is able to demonstrate to him by means of special methods at his disposal that the motives are present all the same.

A third way by which drives are occasionally classified is based upon the source of the stimuli which arouse, sustain, and direct a person's goal-oriented behavior. *Intrinsic motives* are those past experiences and habits of behaving in particular ways for their own sakes and which activate and direct the responses of a person in another situation. The school child, when motivated intrinsically to be punctual, will arrive at school on time because it is personally satisfying to do so. *Extrinsic motives* are of external origins. By way of the eye and the ear, for example, they come to direct action toward or away from objects generating the inciting stimuli. The school child, if told that he will receive a star on the chart for each day he arrives punctually, is being motivated extrinsically. Within the last few decades educators have been more concerned with educational theories and practices which rely upon intrinsic rather than completely upon extrinsic motivating devices.

## SUMMARY OF RESULTS FROM EXPERIMENTAL STUDIES OF MOTIVATION

1. Warden has counted the number of times a laboratory animal (usually the rat) will cross an electrified grid during an interval of time in order to reach a goal. The strength of the drive was thus measured by counting the crossings when the amount of electric current was constant. The results from this obstruction\* method, as it has been called, showed the following relative strengths of the motive in the order presented: maternal, thirst, hunger, sex, and exploration. These results obtained only under the conditions described. Data on this problem at the human level are not available. Warden also reports that the hunger drive approached a maximal intensity for female rats 48 hours after the last feeding and for males at 96 hours. Thereafter, the strength of the modified drives in the two sexes decreased.

2. Tolman, experimenting with groups of laboratory rats, varied the incentive in the food-box of a maze\*. Hungry rats slowed down in their speed of running and made more errors, when water was substituted for food. With food as a reward, the less hungry rats learned more slowly than hungrier animals. It is concluded that all learning is motivated, and that increase in the strength of a drive, up to a certain point, will accelerate the speed of learning. Other investigators (Yerkes and Dodson) have shown that beyond an *optimal* degree in motivation, experimental animals learn less readily and show disturbances in behavior. Too strong and too weak motivation are not conducive to optimal efficiency in learning.

3. Several studies have shown that knowledge of their own advancement in school increases the output of students as compared with the work of groups kept in ignorance of their daily accomplishments. The application of this finding as to the need for grading and returning examination papers to students is clear.

4. There is evidence that knowledge of their general success may of itself motivate individuals. Students who achieve the *levels of aspiration* (goals) which they have set for themselves

may then rise beyond these aspirations and succeed with more difficult tasks. On the other hand, continued failure to achieve goals tends to lower the level of aspiration.

5. Studies measuring the effect of praise and reproof on efficiency of children in school situations have shown that as a motivating agent praise\* is much more effective than negative criticism and blame. Reproof\*, however, is better than completely ignoring individuals in a classroom situation.

6. Maller and others have tested the relative effectiveness of co-operation and competition as agents of motivation in classrooms. The evidence shows that in American culture, competition is a stronger activity-inducing agent than co-operation. Children prefer to compete as individuals, and they appear to accomplish more under this condition than when competing in groups with other equated groups. Working for the self was likewise found a more potent factor than working for the good of the group. These results, interesting and practical as they are, have been obtained from our own culture. To what extent they would apply to different cultures is another question.

7. Experimental evidence suggests that performance scores, such as those obtained in adding columns of numbers, continue to rise if there is an increase day after day in the reward. Obviously, we should expect this continued acceleration to be limited by the physiological\* limit inasmuch as structural limitations cause a cessation in further benefit from practice. Thus within the limits of optimal motivation, increasing the reward may be accompanied by more efficient performance.

8. Selection of a vocational goal suffices, likewise, to lend purpose to one's scholastic endeavors. For this reason, students who have selected their vocations tend on the average to be more efficient than students who have not yet chosen their occupations.

## FRUSTRATION AND CONFLICT

Short stories and novels frequently have as their plots the reactions of their characters to frustrations and conflicts.

By frustration\* is meant the absence of any adequate habit response pattern on the part of a person to obstacles which prevent the attainment of a desired goal. Such a person is said to



be *frustrated* or *thwarted*, since he does not know what to do in face of the barriers (obstacles) in his goal-directed behavior. The bride left waiting at the altar will suffice for an illustration. Obstacles which may block motivated behavior are legion. Generally speaking, they may be classified as *physical* (e. g., an empty ice-box for the hungry person), *social* (e. g., a blue law rigidly enforced), and *intellectual* (e. g., a lack of information). Frustrated individuals usually revert to trial and error in their attempts to surmount the barriers.

By conflict\* is meant the presence of a complex stimulating situation to parts of which the person is motivated to make different and antagonistic responses. To see a friend cheating in an examination, for instance, may result in conflict between one's past trainings and one's desire to do as well as the friend. Thus, the difference between frustration and conflict has to do with the availability of previously acquired responses. When we are frustrated, there are no such responses. When we are in conflict, there are several rival responses any one of which might be made in response to a particular aspect of the stimulating situation. Responses in conflict situations are likely, therefore, to be *selective* and of a *compromise* nature.

### ADJUSTMENT TO FRUSTRATION AND CONFLICT

When frustrated, we may arrive at a trial and error solution. This solution, if repeated, becomes well established by learning. In an identical or similar situation at a later time this solution is used as a "way out" of the difficulty. This process indicates once more the role of learning in frustrated behavior. So, too, in conflict arousing situations a mode of adjustment to the difficulty is so frequently used that it becomes habitual. These acquired habits by which man gets around frustrations and conflicts in his efforts to satisfy his conscious and unconscious motives are called adjustment\* mechanisms. Frustrations and conflicts are expected in any complex society, and since men often learn to react to them in rather specific ways, these characteristic habitual modes of adjustment have been given specific names as designations. These modes of adjustment are most frequently classified on the basis of the responses made to frustrating and conflict-induc-



ing situations. Adjustments by attack, defense, escape, and surrender comprise this fourfold classification. In addition, however, a number of still more specific methods of adjustment have come into general usage. These are listed and defined in Table 2.

1. *Adjustment by attack.* When goal-directed behavior is blocked, some people try all the harder to overcome the obstacle in order to reach the desired end. If they attempt to remove the barrier and to proceed directly to the incentive, their adjustment is by *direct* attack. If they attempt to achieve the goal by a more circuitous route, this effort is called an *indirect* attack. Frequently the indirect approaches take the forms of sublimation\* and substitution\*. To sublimate one's goal-directed behavior means to substitute other socially and personally acceptable goals for those unattainable. Sublimation has been used by Sigmund Freud\* as the final step in his psychoanalytic\* method of treating behavior maladjustments. To substitute one's original goal means to replace the desired object or event with another socially less desirable one. This distinction between sublimation and substitution is purely in terms of social desirability. To the degree that these mechanisms eventuate in the attainment of goals similar though not identical with the original, they are indirect ways of achieving adjustment.

2. *Adjustment by defense.* Some people, when frustrated or in conflict, learn to defend their actions both in deed and in word (symbolically). These defenses, since they prevent other people from knowing about our failures and since they often help us deceive ourselves with respect to our own motives, frequently become habitual modes of responding to difficulties. In defense, therefore, one may over-compensate\* or exaggerate some trait\* considered socially desirable, in order to cover up other imagined or real deficiencies. One often finds evidences of rationalizations\* in conversations wherein a person gives false reasons for his actions in order to deceive other people as well as himself. These deceptions are merely attempts to protect one's self from losing social approval. Upon other occasions we may find ourselves guilty of projection, which means that we unconsciously ascribe to others our own deficiencies and difficulties.

3. *Adjustment by escape\**. In some frustration\* and conflict\* situations one may avoid the difficulty altogether by physically running away from the situation. In other instances one may adjust to the difficulty by withdrawing psychologically, that is, by ignoring the conflict. Kurt Lewin has called this psychological escape\* mechanism the *aus-dem-Felde-gehen\** response ("going out of the field"). Several modes of response are looked upon by psychologists as withdrawal or escape mechanisms. One may identify one's self with a cause or an object, and, thus, imagine one is in possession of the desired goal. We all identify ourselves (the mechanism of identification\*) to a degree with actors in a play or with characters in an exciting novel. In this connection it is clear that marked degrees of day\* dreaming (phantasy\*) may also serve as substitute escape mechanisms for a direct attack on the problem. The individual may regress\* (revert to childish modes of response) in order to escape facing the conflict. The person may repress\* (force out of consciousness) the unpleasant conflict or frustration and so escape. One may escape, to a degree, by so behaving that pity and sympathy are extended by friends and relatives. Sympathism\* helps one feel the situation does not have to be faced. Another way of escaping conflict resolution is by developing, unconsciously perhaps, what are called logic\* tight compartments. In this way the problem is not raised since the various aspects are not related and integrated. The man who is a Sunday religious fanatic and a Monday swindler is an illustration of this form of adjustment. When the cleavage between memories, motives, and action becomes rather marked we say that the person is escaping conflict by dissociation\*, that is, by a break up among associations. Dual and multiple personalities are cases of this type of conflict resolution.

TABLE 2

## ADJUSTMENT MECHANISMS

This outline contains a list of the most frequently encountered mechanisms of adjustment. Each has been defined. Attention is called to the fact that different writers classify these specific mechanisms in different ways. A thorough study of the specific situa-

tion would be necessary in most instances to classify these habit-mechanisms as one of attack, defense, escape, or surrender.

1. Sublimation—adjustment by substituting for the unobtainable a socially acceptable goal.
2. Substitution—adjustment by accepting a socially disapproved goal for an unobtainable one.
3. Rationalization—adjustment by giving false reasons to justify acts initiated from other motives than those given. Self-deceiving, biased reasoning characterizes the rationalization mechanism. The “Pollyanna, Sweet lemon, and Sour grape” reactions are often of this type.
4. Compensation—adjustment by effort in a new endeavor to counterbalance failure in another.
5. Overcompensation—exaggerated and often aggressive acts which draw attention away from real or imagined failures.
6. Projection—adjustment by attributing unconsciously to others one’s own feelings and deficiencies.
7. Identification—adjustment by forming emotional ties with persons or situations possessing one’s desired though blocked goal.
8. Sympathism—adjustment by being pitied and thus escaping expected performance of duty. The “Martyr Complex”.
9. Regression—adjustment by reverting to infantile, childish, or adolescent modes of response.
10. Dissociation—adjustment by a marked degree of personality disintegration. Present in unusual degree in those rare cases of dual and multiple personality. Present in less degree in adjustment by development of *logic tight compartments*.
11. Psychoneurosis—adjustment, it is assumed, by escape into a mild mental or personality disorder.
12. Psychosis—adjustment, it is assumed, by escape into major mental disorders.

13. Hypochondriasis—adjustment by escape from facing one's problems by showing sincere over-concern for one's health.
14. Malingering—escape from difficulties by consciously feigning illness.
15. Suppression—adjustment by consciously aiming to forget the unpleasant event, unobtainable goal.
16. Repression—adjustment by which unobtainable goals and unpleasant events are unconsciously forgotten.
17. Fantasy—adjustment by escaping from reality by daydreaming during which one imagines the solution of the difficulties. Conquering and suffering hero-reactions are of this type.
18. Worry—a non-adjustive reaction involving the development of specific subacute forms of fear.
19. Anxiety—a non-adjustive reaction involving the development of generalized subacute fears of the future.

In theory, some psychiatrists look upon the psychoses\* (the medical term for the insanities) as escapes by mental illness from conflict\* and frustration\*. They, too, believe that the minor behavior disorders, called the psychoneuroses\*, are escapes from unbearable conflict and frustration situations. This interpretation, regardless of its final validity, has led to detailed psychological study of the insane (psychotic\*) and of the neurotic patients. Both groups of disorders are believed to achieve escape for the patients by the simulation of ailments. The hypochondriac\*, for example, is a person who, though in good physical health, sincerely believes himself to be in a state of perpetual poor health.

Within recent years several investigators have reported the induction of abnormal behavior in animals by experimental means. The "experimental neuroses," as they have been called, have been developed by the rat, the cat, the dog, the sheep, the pig, the dove, and the monkey. In general, these studies indicate that the abnormal reactions elicited are the results of conflicts between antagonistic habit patterns already acquired by the

animals. Also, some animals<sup>1</sup> of one litter develop the abnormal reactions more rapidly than do those of another, indicating evidence for what some have called a "constitutional predisposition" toward breakdown in stressful situations. The comparative approach is profitable in this problem because human subjects cannot be so treated and because conditions can be much better controlled in the laboratory. The approach also provides for the study of the genesis, course, and treatment of abnormal behavior at the animal level. Information is now being accumulated on this practical problem which may aid a better understanding of human neurotic and psychotic conditions.

4. *Adjustment by surrender.* In some instances, individuals do nothing to resolve the conflict and to remove the barrier when frustrated. They merely accept what they call the inevitable. Thus, Pollyanna\* remarks that "things might be worse," and so does nothing. An individual may, in a sense, emulate the ostrich and stick his head in the sand, thereby surrendering to as well as escaping from the difficulty. This is the well known ostrich\* complex. In certain cases, these attitudes of surrender result in subacute forms of fear. This form of response is known as worry\*. In other cases, surrender leads to the development of a generalized, vague fear of the future known as anxiety\*.

To pass an ethical judgment upon each and all of these mechanisms of adjustment is a social and philosophical problem and only indirectly psychological. The "goodness" or "badness" of any one of these modes of adjustment is always one of degree and is further related to the specific situation of conflict or frustration. No rule can be laid down concerning the advisability of adopting any one mechanism as the most desirable reaction when in conflict or when frustrated.

The principle that man should learn to face and, if possible, to solve his problems as they arise, has been amply demonstrated by those who promote the Mental Hygiene Movement. This social movement was initiated early in the 20th century in the United States. Its inception was due chiefly to the influence of Clifford W. Beers and his book entitled *A Mind that Found Itself* (1907).

<sup>1</sup> N. R. F. Maier, *Studies of Abnormal Behavior in the Rat*. New York: Harper, 1939. Pp. 81.



Beers described his experiences as a patient in mental hospitals, and, later, upon his discharge, acted as a leader in a reform movement. The movement gained impetus until it became international in scope, and proved itself highly influential in the dissemination of information on how to live efficiently and happily. Conflict and frustration, problems of human adjustment which are essentially problems of human motivation, should be solved, and so, in turn, make for continued social and personal achievement. Energy may thus be conserved for the benefit of the person and society.

### ADJUSTMENT AND NORMAL BEHAVIOR

Only a small percentage of people ever develop abnormal behavior patterns in response to long continued conflicts and frustrations. Of these few some may gradually develop a *psycho-neurosis*\* or a *psychosis*\*. The "neurosis," as it is sometimes called, is a minor disturbance in behavior which some authorities believe to represent an attempt to escape from conflict\* or frustration\* of long duration. The French physician, Pierre Janet\*, has made an extensive study of the psychoneuroses and has classified these "adjustment mechanisms" into three major groups: (1) psychasthenia\*, characterized by phobias\*, or obsessions, or compulsions; (2) hysteria\*, characterized as an "emotional revolution"; and (3) neurasthenia, described as the "nervous breakdown." Only a very small number of the psychoneurotic patients are ever found in mental hospitals. Few of them, indeed, ever develop the more serious major mental disease known to the medical practitioner as a psychosis\*.

The psychotic patient is one who is called insane by the members of the legal profession and of society. By insanity\* is meant a person's incapacity because of a mental disease to manage his own affairs. Kraepelin\*, the father of psychiatry\*, late in the 19th century classified the psychoses\* into two major groups, the organic\* and the functional\*. Although some physicians, experienced in the diagnosis and treatment of mental disorders (they are called psychiatrists), have criticised this twofold grouping, it is still in general use.

Organic psychoses are those whose *immediate causes* are physio-

logical in nature. Alcohol, morphin, cocaine, and syphilis are illustrations of factors which may result in the gradual development of psychoses of this general type. The more remote causal factors are more difficult to ascertain. Why a man drinks too much alcohol over a long period of time, only to develop alcoholic insanity, is perhaps more pertinent to the successful treatment and re-education of the patient than is the mere fact that alcohol is the immediate causal factor. Functional\* psychoses are those major mental diseases assumed to be the result of protracted periods of maladjustment and of possible hereditary factors as yet not well understood. In these cases, no positive evidence has been found to indicate any changes in the brain similar to those observed in the analyses of cortical tissues in cases of organic psychoses. It is believed, consequently, that the functional psychoses are of psychogenic origin rather than of physiogenic. The two most common functional abnormalities of this general type are called schizophrenia\* (once known as dementia\* praecox), characterized by a marked lack of co-ordination among the intellectual, the emotional, and the motor aspects of man, and manic-depressive\* psychosis. The latter is an insanity characterized by emotional extremes.

The treatment (therapy) of cases of the psychoses includes the use of drugs and other physiological agents as well as the use of numerous psychological aids. Within the last decade several advances have been added to the treatment program so important in every mental hospital. Sakel and Wortis, two Vienna physicians, have developed the method of insulin\* shock in the treatment of schizophrenia\*. Von Meduna, the Hungarian physician, has recently devised the method of inducing artificial convulsions in the psychotic\* by means of the drug, metrazol\*. He has demonstrated that these convulsions appear to act as therapeutic agents in the treatment of schizophrenia. Himwich and others in the United States are working upon the method of providing increased amounts of nitrogen in the air to be inhaled for short intervals by schizophrenic patients. Modern research laboratories have developed the artificial fever chamber for the treatment of syphilitic insanity ( paresis\*). The mental hygienists have aided by teaching the general public to look upon mental

disease from the same point of view as it looks upon cases of physical ailments. Psychiatrists and psychologists have discovered, likewise, the therapeutic value of music, color, games, movies, and related activities in the treatment of the mentally ill. This type of treatment is called psychotherapy\*. Numerous agencies are thus working toward the development of an enlightened attitude on the part of the public toward behavior abnormalities.

### APPLICATIONS OF THE STUDY OF MOTIVATION

The importance of motivation\* in daily life cannot be over-emphasized, for without the energizing and directing factors called motives our world and our experiences would indeed be very different. The following selected illustrations suffice to indicate the broad scope of man's wants as directive agents in behavior.

In *advertising*, copywriters are familiar with the psychology of motivation, since their advertisements must always appeal directly to human wants. To verify this statement, select at random advertisements from any current magazine or newspaper. Identification of the motives upon which each advertisement is based is a splendid way to learn to distinguish between primary and secondary drives as well as to observe in action the wide range of motives to which manufacturing companies appeal in order to sell their products. An advertisement, it is noted, is always based upon at least one human need, for example, that of *subsistence*, *social approval*, or *mastery*. Often, however, several human wants are appealed to in the same advertisement. The advertisement, therefore, serves as an incentive to direct people to that product, the goal.

In *salesmanship*, likewise, the company representative must be familiar with those factors which combat sales resistance and those which direct the prospect's thoughts in the desired direction. The salesman must know how to help resolve the conflicts which arise as a consequence of the interview. Those who, for instance, are prevented financially from outright purchase of an automobile, are assured by the salesman that a liberal credit plan has been arranged for the convenience of those who need additional time to pay in full. The efficient salesman is thus able to overcome

"sales resistance" by removing in devious ways the objections raised by his potential customer. He is also able to intensify the felt need for the product which he represents. The psychology of selling is the psychology of motivation\*.

In the dissemination of propaganda\* the elemental wants of many people are appealed to in order to convince them that the plan advocated by the speaker is the only way by which to prevent further frustrations\* in the satisfaction of their basic wants. Subsidiary devices are also used in propaganda. Persons are consciously or unconsciously led to conclude that any other procedure than the one suggested is wrong, because, for example, several eminent "authorities" are said to favor the present plan. Appeal to prestige is often used as a technique for swaying public opinion on a current issue. In propaganda, therefore, people are taught to accept a particular approach to the solution of social and economic problems because direction is given their thinking by those expert in the dissemination of propaganda.

In *industry*, recent studies<sup>2</sup> have indicated the importance of motivating agents other than the financial. In addition to the weekly pay envelope other incentives\* have been found to serve as goals toward which to strive in industry. Social and personal values, such as those related to self-respect, serve to direct behavior in certain channels. If these values are thwarted, labor dissatisfaction ensues. Money alone is not sufficient for the control of human behavior in our culture.

In *education*, the proponents of the mental\* hygiene approach emphasize the need for the use of right kinds of motives in the educative process. This emphasis, they hold, is necessary because the nature of the incentives used in the classroom determines to a considerable degree the nature of the developing personality\*. Modern educators, therefore, demand that student motivation be intrinsic\*, that is, arise from the task itself. The value which the problem possesses for the satisfaction of the student's felt needs is sufficient for the direction of the pupil's problem solving activities. Extrinsic\* forms of motivation, such as paper stars, grades, honor rolls, establish false goals toward which to work. The

<sup>2</sup> F. J. Roethlisberger & W. J. Dickson, *Management and the worker*. Cambridge: Harvard University Press, 1939. Pp. 615.



modern teacher, therefore, relies upon the use of techniques which elicit a felt need on the part of the student. The satisfaction of this need is the reward.

These illustrations suggest the extent to which man's wants function in everyday life. The psychology of human motivation is thus a study of the nature of man's needs and wants as well as a study of his adjustments to them.

### TEST QUESTIONS

A. *True-False Statements.* Study each statement and decide as to its truth or falsity.

1. Drives are usually of internal origin.
2. Drives arouse and sustain diffuse activity.
3. Motives are drives modified by learning.
4. Incentives give direction to human behavior.
5. Emotion-inducing stimuli motivate human behavior.
6. Freudian theory has influenced psychiatry practically not at all.
7. The Id is controlled by the pleasure principle.
8. The libido, for Freud, is completely sexual in nature.
9. The Ego is governed, under normal conditions, by the pleasure principle.
10. The Super-Ego is equivalent to the popular conception of one's "conscience."
11. According to Freud psychoneurotic reactions are always the result of sexual maladjustments.
12. Adler's theory of a single drive to action has been generally accepted today by experimental psychologists.
13. According to Lewin, a dynamic relationship exists between tissue needs, tensions, and valences.
14. The frequency and nature of the barriers to goal-directed behavior influence the genesis of personality traits.
15. Sensory stimuli always exert some effect upon the organism.
16. Hunger sensations in the neonate are accompanied by general motor restlessness.
17. Failure experiences may lower the level of aspiration.
18. Conflicts and frustrations are to be expected in any complex society.



19. Motives can be classified readily on the basis of their sources into primary, or physiological, and secondary, or social.
20. Motives may be conscious or unconscious.
21. Man's tendency to maintain optimal conditions for living is called by Cannon the principle of homeostasis.
22. Purpose in behavior means that human behavior can be accounted for upon occasion in terms of future causes.
23. Adler's will-to-power is considered today as a first-order drive.
24. Unconscious motives may become conscious.
25. Man's learning efficiency cannot be interfered with if he is too strongly motivated.
26. Working for the self is more efficient in the classroom than working for the good of the group.
27. The physiological limit can be exceeded only by the most extreme of motivating conditions.
28. When frustrated, man has no adequate habit patterns by which to adjust.
29. Dual personality is an illustration of adjustment by dissociation.
30. The hypochondriac pretends he is ill to escape facing his difficulties.
31. Studies on experimental neuroses in animals offer evidence in support of the psychogenic theory of the psychoneuroses.
32. The Mental Hygiene Movement is now international in scope.
33. Insanity is a social and legal term.
34. The psychoanalytic technique is an illustration of psychotherapy.
35. Advertisers rarely appeal to human drives in their copywriting.

B. *Completion Statements.* Read the incomplete statements and decide on the words that would complete each statement.

1. Incentives direct or canalize human behavior toward particular .
2. The doctrine of \_\_\_\_\_ was once held to account for the energizing and directing of human behavior.
3. Freud assumes that the three instincts, called \_\_\_\_\_ , \_\_\_\_\_ , and \_\_\_\_\_ , are energized by the \_\_\_\_\_ .
4. The reality principle counterbalances the influence of the \_\_\_\_\_ principle.

5. The Ego is more often \_\_\_\_\_ than \_\_\_\_\_
6. Adler assumed that the will \_\_\_\_\_ was \_\_\_\_\_  
rather than acquired.
7. Tension, according to \_\_\_\_\_, is induced by  
needs.
8. To eat any food when hungry is an adjustment to a  
order drive.
9. To solve a mathematical problem for the satisfaction which ac-  
cruces from its mastery is an illustration of \_\_\_\_\_  
motivation. This type is advocated by educators and  
members of the \_\_\_\_\_ movement.
10. Mary is afraid to stay away from the play. She is illustrating  
the motive of social \_\_\_\_\_.
11. The \_\_\_\_\_ method is used to study the  
strengths of animal drives.
12. Less hungry laboratory animals learn a \_\_\_\_\_ less  
than more hungry animals when the goal  
is food.
13. \_\_\_\_\_ is more effective as a motivating  
agent than is reproof.
14. Obstacles to goal-directed behavior are classified as follows:  
(1) \_\_\_\_\_; (2) \_\_\_\_\_;  
(3) \_\_\_\_\_.
15. Frustrated individuals usually revert to \_\_\_\_\_  
attempts at solution, while those in conflict often  
arrive at \_\_\_\_\_ solutions.
16. Adjustment mechanisms, if well established by learning, become  
, and as such, they achieve the status  
of traits of \_\_\_\_\_.
17. \_\_\_\_\_ and \_\_\_\_\_,  
as adjustment mechanisms, differ only in the degree of social  
approval extended.
18. Four major types of adjustment mechanisms are called: (1)  
\_\_\_\_\_; (2) \_\_\_\_\_;  
(3) \_\_\_\_\_; and (4) \_\_\_\_\_.

19. To ascribe to others one's own deficiencies is called adjustment by
20. adjusts by saying "All might be worse."
21. To escape by childish tantrums is adjustment by
22. is a specific form of fear response, while is more generalized and vague.
23. Janet classified the psychoneuroses into (1) ;  
(2) ; and  
(3)
24. Kraepelin classified the psychoses into the and groups.
25. The psychoses are of known physiological causation, while the assumed to be caused by factors are
26. Two functional psychoses are called , and  
or
27. Paresis is another term for the organic psychosis called
28. , and  
are three recently devised physiological treatments for the functional psychoses.
29. In the dissemination of the drives of man are frequently appealed to.
30. Modern educators believe that honor rolls may become illustrations of motivation, and hence, establish false goals toward which to work.

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## CHAPTER SEVEN

### *Learning*

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#### WHAT LEARNING IS

THE FACT that man and other animals learn has long been known. It has also been amply demonstrated that man is capable of solving more difficult problems than other animals. Although infra-human forms are capable of learning\*, they depend for survival more than man does upon a high fertility rate and upon the inheritance of biologically adaptive mechanisms, such as protective coloration. Man's survival, on the other hand, is to a greater degree the consequence of his capacity to profit from experience. Learning, as a tool, aids man in the development of an elaborate social organization which, in turn, facilitates his own adjustments to his environment.

"Learning" signifies that man's behavior has been modified as a consequence of stimulation. The child who holds his finger in the candle flame does not do so again. His behavior\* has been modified, or changed, in response to the sight of the flame. A new stimulus\*-response relationship has been formed. He has learned.

#### WHEN MAN LEARNS

Learning takes place most effectively under the following conditions. First, man learns when faced with a problem. He learns when his wishes and desires are blocked. Second, man learns when he is structurally and functionally capable of learning. This is to say that learning depends upon the maturation\* of structures



essential for the acquisition of new stimulus-response connections. To illustrate, a child of ten cannot acquire responses so complicated as those by an adolescent. Just as learning depends upon the degree of development of the neuromuscular systems, so, too, does this increase in complexity (maturation) depend upon exercise and learning. The interaction\* between learning and maturation of structures has been frequently discussed and investigated. Evidence has been supplied on this point by Myrtle McGraw in her co-twin\* control studies of Johnny and Jimmy. Johnny's early training in tricycling did not result in long continued superiority in motor learning over the control\* twin. Jimmy soon "caught up" with Johnny. McGraw's studies illustrate that training to be most effective must be offered when the child is mature enough to profit from it in an optimal way. Precocious training has not resulted in any permanent superiority of those so trained. Third, the acquisition of new performances occurs only when man is motivated. Within limits man learns more rapidly the stronger the motive\*. Man learns, therefore, most effectively when mature enough and when in the presence of a problem situation which motivates him to learn.

### WHAT MAN LEARNS

It is readily granted that one learns in many kinds of situations. Attempts to classify these situations in terms of what man learns have been made. The following classification is offered because of its usefulness rather than because of its all-inclusiveness. Since man learns or acquires skilled acts (dancing, swimming, typewriting) we speak of motor\* learning. Inasmuch as man learns to recite poetry and to speak and write a foreign language, we speak of verbal\* learning. Finally, since man acquires new ideas and new meanings in problem situations, we speak of ideational\* learning. This third type is often observed in the solutions of abstract mathematical problems. Some have considered ideational learning to differ from motor trial-and-error\* learning only in the sense that the solution is the result of mental trial-and-error. These three types of learning are based upon the nature of the subject matter learned. Each type has been used as a basis

by psychologists in their study of how man remembers and forgets. By way of the learning process, man acquires skilled acts as well as verbal and ideational materials.

### HOW MAN LEARNS

Numerous studies investigating how man learns have shown that man can acquire new modes of reacting to stimuli in any one of four ways. These are called learning by *associating*, by *trial and error*, by *insight*, and by *conditioning*.

1. *Learning by association\**. Philosophers in early times were concerned with the origin of symbols, called ideas, which represented, at the moment of thought, one's past experiences. Aristotle was among the first to stress the fact that our ideas, in the form of words and mental images, are by-products of learning by association. He formulated four descriptive laws to characterize the conditions under which man associated one item of experience with another. These laws he called association by contiguity\* (the items occur together in time and space, such as table and chair), by succession\* (items follow each other as in the alphabet), by similarity\* (tea and coffee are both beverages), and by contrast\* (large and small). The real test, of course, of learning under any one of these conditions is the reinstatement of one of the items when the other (acting as a reduced\* cue) is presented at a later period.

More recently psychologists have shown that, instead of Aristotle's four, two basic principles of contiguity\* and assimilation\* can account for man's associations. Those elements which are experienced together in time and space (or in rapid succession) are *contiguous*. One presented at a later time will recall the other. A lightning flash is thus associated with approaching thunder. Novel elements of experience are absorbed, so to speak, or assimilated into our previous experiences by virtue of the similarities of the new elements to known objects. New associations are consequently built up. An unusual sound is shortly associated with wind in trees. The new is assimilated into the old. Thorndike has used the principle of belongingness\* to designate this connection between the elements of our experiences that have

been acquired by associative learning. By this term he means that one item appears to "belong" to another as shown by tests of recall. Learning by association obviously plays an important role in the acquisition of words (verbal learning) and of new ideas and meanings (ideational learning). Associative\* learning also serves as the basis for recall of the past by means of reduced\* cues and for the manipulation of symbols in solving mental problems.

Although learning by association can be characterized in terms of the principles mentioned above, the structural counterparts are less well understood. The fact that the central\* nervous system is essential for learning through association has been demonstrated by study of the detrimental effects of brain injury upon recall. One theory holds that a pathway of lowered synaptic resistance between two or more active neurone\* systems is established by associative learning. If, at a later time, one unit alone is excited, the other will follow it. Learning by association is thus believed to possess structural counterparts.

2. *Learning by trial and error.* That man and other animals acquire skills by means of trial-and-error\* procedures is well recognized. To this method of learning are attributed the following general characteristics: (1) man and other animals *explore* and investigate the situation (such as a maze\*); (2) they gradually eliminate the errors which they make early in their attempts at a solution; (3) they differentiate the correct modes of response from those which are incorrect; (4) they *fixate* those correct responses by practice. *Exploration*, *selection* of the correct, *elimination* of the incorrect, and *fixation\** describe, therefore, what man and other animals do during their acquisitions of complex motor reactions.

Trial-and-error\* learning has been studied extensively by Thorndike, who has observed numerous animals learning "by doing" in problem situations. For these studies he used maze patterns and puzzle boxes. Harter performed with Bryan classical studies, along similar lines, in which the human subject under observation learned to receive and to send telegraphic messages in code. Swift, Bair, and Book studied man's acquisition of the typewriting skill. These and other early investigators stimulated

additional research in connection with the motor trial-and-error method of learning.

When a subject learns by this method, the experimenter takes records of what the learner does. These *raw data* may be recorded in terms of the length of *time* needed to acquire results such as the maze habit or the typing act. They may also be recorded in terms of the number of *errors* made on each trial or in each unit

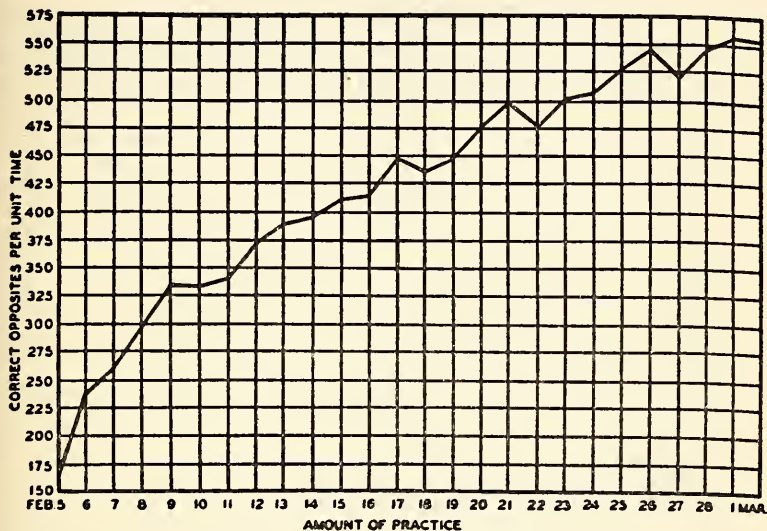


Fig. 19. A sample learning curve. (Reprinted with permission of Scott, Foresman and Company from Ruch, *Psychology and Life*, 1937, p. 540. The figure is based on data included by Thorndike in *Adult Learning*, 1928. Reprint permission is also extended by the Macmillan Company, publishers of *Adult Learning*.)

of time. The number of *successes* made in each practice interval may likewise be noted. The experimenter then proceeds to arrange these scores on graph paper. The time taken, the errors made, or the successes observed for each trial are plotted. By connecting the points with a pencil, learning\* curves are constructed for the subjects. Fig. 19 shows a sample learning curve. Note that the trials are listed along the x-axis\* or abscissa\* of the graph\*. The

measures of the speed of learning in terms of time, errors, and successes are arranged along the y-axis\* or ordinate\*.

The learning curve tells the psychologist much about the acquisition of motor skills.

First, no single learning curve can be said to be typical of the learning of all people in all sorts of situations. Numerous fluctuations in the curves exist from subject to subject and from time to time. No one can speak correctly of *the* learning curve.

Second, the curves obtained from several subjects in a given experiment illustrate the principle of individual\* differences applied to the rate of learning. Not all people learn at the same

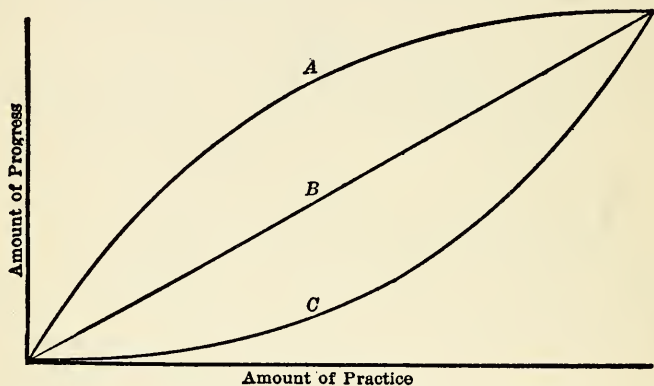


Fig. 20. Representative learning curves. (Reprinted with permission of Longmans, Green and Company from Carr, *Psychology: A Study of Mental Activity*, 1925, p. 218.)

speed. Indeed, the normal\* distribution curve best characterizes the speed of learning among a random\* sampling of subjects.

Third, the general shapes of the learning curves tell us whether or not learning goes on at an equal rate until the new act is well fixated. Study of the learning curves obtained from cases of individuals who acquire motor skills in the laboratory, indicate that the curves are usually one of two general shapes. If the subject has had some experience with kindred activities, the learning rate is usually rapid at first and slower later. Success and error scores then yield *negatively accelerated curves*. Curve A in Figure



20 is illustrative. If the subject has had no previous experience related in any way to the new skill to be acquired, recent evidence suggests that the speed of learning is slow at first, faster for a time, and then finally becomes slow again. Scores obtained under these circumstances yield the S-shaped curve. This curve would be a combination of Curves A and C in the figure. Curves B (those of *zero acceleration*) and C (those of *positive acceleration*) are not ordinarily obtained when man's scores in learning experiments are plotted.

Fourth, the acquisition of skilled acts is limited by the physiological\* limit. No one can learn to run at the rate of a quarter mile in ten seconds. Such a feat is prevented by structural limitations. This fact is shown in learning curves by the levelling off of the graphs at the later stages after continued practice.

Fifth, the learning curves for the acquisition of very complex motor skills often show flat places indicative of the fact that continued practice is no longer resulting in progress. The flat places are called plateaus\*. These "slumps" may be due to various factors. Fatigue and boredom may account for some of them. Interference between that which is already learned and the present task may account for others. The process of organizing elements of the present skill already acquired with the elements being mastered may account for still other plateaus. The psychologist has studied these learning curves because they tell him so much about the process of learning.

To account for learning by trial-and-error methods, Thorndike formulated three laws of learning. Although it is now known that these laws do not possess universal application to all trial-and-error learning situations, they still are used to help explain how man learns skilled acts.

The law of effect\* holds that a new response is strengthened or weakened by the satisfaction or the annoyance which accompanies or follows it. This principle is used to account for the selection of correct (satisfaction) and the elimination (annoyance) of the incorrect modes of response in a maze or puzzle box. The use of rewards which satisfy and of punishments which annoy is a direct application of the principle to classroom situations.

The law of use\* states that, other factors being equal, practice tends to strengthen the new response. For this reason drill in learning the multiplication tables is frequently used. This principle is used to account for fixation\* of the responses already selected as a consequence of the operation of the law of effect.

The law of readiness\* holds that the more completely the subject is ready to respond in a particular way, the more satisfying it will be to do so. The effort to motivate\* pupils in the classroom and to prepare them for what is to come by arousing interest\* is an application of the principle of readiness.

These three laws of learning formulated early in the twentieth century by Thorndike are generalizations based upon many human and infrahuman learning experiments carried out by the pioneer worker in this field. That these principles have influenced educational theory and practice in a very real way cannot be over-emphasized.

Within the past few years<sup>1</sup> Thorndike has modified the principles of effect and exercise\* or use. The modification is necessary because several experiments have shown that these two principles do not always apply to all trial-and-error\* learning situations. The law of effect\* has been modified as follows. Responses accompanied or followed by satisfying states of affairs are readily learned. Responses accompanied or followed by annoying experiences are not always unlearned, eliminated, or forgotten. This fact is well illustrated by experiments which show that man learns rapidly certain reactions which are highly distasteful to him. Elimination of errors in learning must be accounted for in other ways than by the application of the law of effect. The law of exercise\* or use has also been modified. Recent evidence indicates that this principle of practice is ineffective unless accompanied by the experience of belongingness\*. If the materials to be learned are grouped in such a way that they favor comprehension of the meaningful relations (that is, if they appear to *belong* together), practice or repetition is distinctly effective. If the items to be learned do not belong together exercise is ineffective. The laws of effect, exercise or use,

<sup>1</sup> E. L. Thorndike, *The Fundamentals of Learning*. Bureau of Publications, New York: Columbia University, 1932. Pp. 638.

and readiness, although more correctly designated as principles today, are still used upon occasion as explanations of how man learns in trial-and-error situations.

3. *Learning by insight*\*. The acquisition of new modes of response may result from either overt\* or covert\* procedures. Wolfgang Köhler\*, the German Gestalt\* psychologist, however, holds that the solutions of problems need not always be arrived at by motor or ideational trial and error. He maintains that many animals may solve these problems by insight\*. By insight he means that the subjects may suddenly see the elements of the whole situation in a new light. This new way of looking at the problem (called *perceptual reorganization*) leads directly to the solution. Insightful learning is believed by some investigators to have occurred when learning curves show sharp and permanent drops in error scores.

Köhler's evidence for learning by insight comes from studies of the performance of apes<sup>2</sup> when presented with problems in their everyday environment. To illustrate, he noted that one ape suddenly put two poles together in the form of a tool in order to reach a bit of fruit suspended above the cage. The sudden solution of this problem followed a series of trial-and-error attempts, none of which was successful. Insightful learning may, therefore, be accompanied by trial-and-error attempts. To characterize the sudden solution of a problem Köhler makes use of the principle of closure\*. This term means, figuratively speaking, that the gap between the goal-object and the animal's wants has been closed. Perceptual reorganization of the situation has resulted in the insightful solution.

Critics still question whether man and other animals learn by insight. Some believe that to obtain conclusive proof for insightful learning the past life of the subject would have to be thoroughly known. If Köhler's apes had at any time in their past experience used sticks and poles as tools, a simpler explanation than that of insight for their present behavior would be that of memory\*. These critics maintain that sharp drops in error scores as seen in occasional learning curves do not necessarily prove that ideational and motor activities are acquired by insight.

<sup>2</sup> W. Köhler, *Mentality of Apes*. Harcourt, New York, 1926.

4. *Learning by conditioning.* Within the twentieth century numerous studies have been made to analyse the way man and other animals learn by conditioning\*. Selected phases of learning by this method are discussed in the following paragraphs.

Learning by conditioning may be discussed from two angles, the *classical* and the *instrumental*.<sup>3</sup>

First, let us consider the classical view. In or about 1900, the Russian physiologist, *Ivan Pavlov*, while studying the digestive glands, made an observation which led to numerous investigations by means of conditioning procedures. One of Pavlov's classical experiments consisted in ringing a bell during the presentation of food. The food alone was observed to evoke an unconditioned response (unlearned), that of salivation, more commonly known as "mouth watering." After several repeated uses of the food-in-mouth and the bell, this glandular response was evoked simply by sounding the bell. The response was called the conditioned\* response. Pavlov termed the bell the inadequate, substitute, or conditioned\* stimulus (CS). He called the food the adequate, natural, or unconditioned\* stimulus (UCS). This classical experiment has been duplicated with many other unconditioned and conditioned stimuli, thereby indicating that man and other animals do learn by conditioning.

Pavlov held that much of human and animal learning is of the conditioned response type. Accordingly, psychologists and physiologists study in the laboratory the formation of associations between stimuli\* and responses, in order better to understand how and what living organisms learn. Attention is called to the fact that learning by association\* as stressed by Locke and other English philosophers emphasized subjectively the formation of associations between memories\* and ideas\*. Pavlov's learning by conditioning is a modern, *objective* illustration of associative formations between known physical stimuli and measurable responses. Conditioning is a new term for observations made as early as the time of Aristotle.

Second, instrumental\* conditioning has been studied. Pavlov's

<sup>3</sup> For a thorough discussion of learning by conditioning the reader is referred to Pavlov, *Conditioned Reflexes*, 1927, and to Hilgard and Marquis, *Conditioning and Learning*, 1940.



technique of simultaneous (or nearly simultaneous) presentation of the natural and substitute stimuli has been modified and extended by American investigators. In these more recent studies the UCS elicits a generalized adaptive response, such as jumping in any direction from an electric grid. The UCS and the CS are no longer strictly simultaneous. The general locomotor activity just mentioned is in marked contrast with the specific and localized responses studied by Pavlov. A buzzer, to illustrate instrumental conditioning, may be sounded and thus serve as a signal for oncoming electric shock. The animal learns to avoid the electric shock by reacting to the buzzer-signal. It is to be noted that the learned response is established, or fixated, partly in the absence of the UCS. The response is reinforced as if by anticipation of the electric current. Such a method of studying the acquisition of a new stimulus-response relationship, called learning, is known as instrumental conditioning. This means that the CR itself provides, or is instrumental in, the reinforcement. For Pavlov the UCS provided for the reinforcement and so for the fixation\* of the conditioned\* response. Classical is differentiated from instrumental conditioning on this basis. It is noted that learning by this method conforms closely to the description given by Thorndike for learning by trial-and-error methods. Learning by instrumental conditioning and by trial and error are different ways of interpreting much the same phenomena.

### HOW THE CR IS ESTABLISHED

The classical conditioned\* response is acquired when the following conditions are met. First, an adequate unconditioned stimulus (UCS) of sufficient strength to induce a specific, localized response is essential. Salivary reactions and limb flexions (foot lifting) have often been used as localized responses to specific unconditioned stimuli. Second, an inadequate (CS) stimulus must be selected—one which does not at the start of the experiment elicit the unconditioned response. Any stimulus (such as light, sound, pressure) to which the organism is normally sensitive may be used. Third, the CS and the UCS are repeated simultaneously, or nearly so, several times. Eventually, the bell, for instance, will evoke the flow of saliva in the absence of food.



This CR is not identical with the unconditioned response made to the food-stimulus. Close resemblance is often present, but identity is rarely found. Fourth, the conditioned stimulus, after its initial establishment, must occasionally be followed by the unconditioned stimulus to prevent *extinction* or dying out of the conditioned response. The simultaneous presentation of the conditioned and the unconditioned stimuli is called *reinforcement* and is essential for the retention of the conditioned response. Fifth, the CR is most readily acquired under rigidly controlled experimental arrangements. These permit the animal subject to respond in one way only, and they prevent extraneous stimuli from distracting the subject. The arrangements shown in Figure

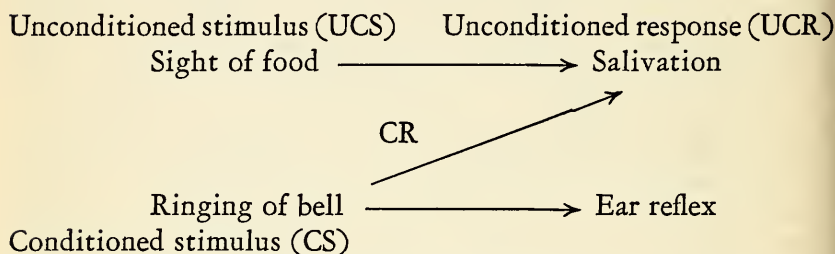


Fig. 21. Diagram of the stimulus-response relationships in Pavlov's classical experiment in conditioning.

21 have often been used because they permit objective study, under controlled conditions, of the acquisition of a relatively simple adaptive act.

### CHARACTERISTICS OF THE CLASSICAL CONDITIONED RESPONSE

1. *Time relations.* The CS and the UCS may or may not overlap in time. If they do, the newly learned CR will appear as soon as the CS is presented. This is called simultaneous\* conditioning. If the CS appears for a short time prior to and ceases with the appearance of the UCS, the CR does not appear immediately with the appearance of the CS. The CR is delayed for an interval proportional to the time between the CS and the UCS. This is

the *delayed conditioned response*. If the two stimuli do not overlap at all, trace\* and time\* reflexes may be observed. If the CS is presented and then followed by a pause of a few seconds or minutes prior to the UCS, the CR will appear at the end of the pause. This result is the *trace* response. If the UCS (such as food) is presented at regular intervals for several days and then omitted, a CR will be observed at roughly the usual time for food presentation. This reaction is the *time* response. The reaction is readily observed among animals fed daily at the same time.

2. *Dominance*. In all conditioning studies, one pair of stimulus-response relationships must be dominant over the second pair. If the bell is eventually to elicit the "mouth watering" response, the sound must be less appropriate as a stimulus for the ear reflex than is the food (UCS) for the salivary reaction (UCR). This characteristic of dominance is clearly evident in reconditioning studies. If a child has earlier been conditioned to fear a white rat, this fear may be lost by training the child *to eat when hungry a favorite dish* (dominant stimulus-response relationship) in the presence of the animal. The rat, however, must be some distance away from the child. If these requirements are not met the child obviously might well develop a marked dislike for the favorite dish. Food antipathies may thus be said to illustrate learning by conditioning. This characteristic of dominance is illustrated in Fig. 21 by placing the dominant stimulus-response relationship first in the diagram.

3. *Inhibition*\*. If the CR is not frequently reinforced the new response is inhibited, i. e., it undergoes *experimental extinction* as a consequence of the training procedure. Hours later the CR may be evoked a few times by the presentation of the CS. This re-elicitation after extinction is called spontaneous\* recovery. If, at another time, an unusual stimulus is presented the extinguished response temporarily appears once more. This process is called disinhibition\* of the inhibited CR. Inhibition means, thus, a decrease in magnitude or a complete loss of the CR, and is an active process.

4. *Generalization and discrimination*. Once the CR has been established to one stimulus, other stimuli similar to the CS will

evoke the CR. This is known as sensory\* generalization. To illustrate, if a dog has learned to respond by lifting its paw to a tone of 1000 cycles, a tone of 596 will also elicit the foot withdrawal. The spread of effectiveness from one stimulus to similar

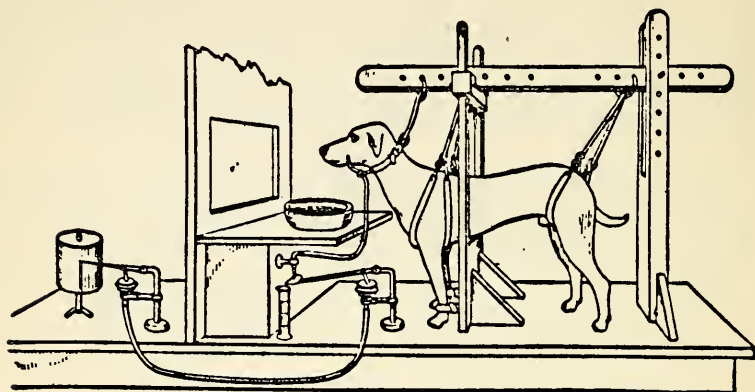


Fig. 22. Diagram to illustrate Pavlov's method of establishing a conditioned salivary reflex. The unconditioned stimulus (food) is presented automatically in the small dish through the window. At the same time, or prior to this, the conditioned stimulus (e.g., the ringing of a bell) is given. The saliva which flows from the dog's mouth is collected in the graduated glass receptacle. As the saliva flows into the receptacle, it strikes a small disc which depresses the level just in front of the animal. This downward movement is transmitted to the lever behind the screen, and an automatic tracing is thus secured upon a smoked drum or kymograph. The kymograph record tells the experimenter how many drops of saliva have been secreted and how regular the flow has been. (Figure and legend reprinted first with permission by R. M. Yerkes and S. Morgulis from the *Psychological Bulletin*, 1909, vol. 6, p. 264, and next by permission by D. Appleton-Century Company from H. E. Garrett, *Great Experiments in Psychology*, 1941, p. 129.)

stimuli may assist the determination, for example, of how acutely animals can discriminate. For these tests, a dog may be trained to respond to a 1000 cycle tone and to inhibit his generalized response to a tone of 596 cycles. By making the 596 tone more

and more like the first tone, the limits of the animal's capacity to discriminate between the tones can be determined. Pavlov, for instance, used this method of contrasts\* when testing the capacities of his animals to tell the difference between visual patterns. He found that the dogs often became "neurotic" when the stimuli could no longer be discriminated. Thus, when an ellipse, the negative stimulus, became more and more like a circle, the positive CS, the dogs "broke down." They lost the positive CR to the circle, and, for a considerable period, were emotionally disturbed. Pavlov was the first investigator to observe the induction of abnormal\* states in animal subjects.

Just as there is an *equivalence of stimuli* for evoking learned and unlearned responses, so, too, is there *motor\* generalization* or response equivalence. To illustrate, the same CS may elicit in the same animal, under certain conditions, response 1 (right foot flexion), and under other conditions, response 4 (left foot flexion). The two responses are equivalent only in the qualitative sense. Psychologists study sensory and motor generalization because these phenomena tell much about man's adaptation to his ever changing environment. If man could use his knowledge and skills only in situations identical with those in which the learning occurred, his past experiences would be of little value. Generalization\* makes for wider applications of that which we have learned. At the same time, certain situations demand selective action, and, hence, require man to discriminate between all previous learnings. Generalization and discrimination\* are both studied for this very practical reason.

## EXPLANATIONS FOR LEARNING BY CONDITIONING

Two groups of theories have been formulated to account for learning by conditioning. First, Pavlov's\* *physiological* interpretation assumes that the brain-cortex is the essential organ in the establishment of conditioned responses. Pavlov's theory of nerve\* action is essentially a drainage\* theory. Two physiological processes or temporary cortical\* states, each the result of specific experimental procedures, are necessary to account for conditioning\*. These two states are called excitation\* and inhibition\*.

Sensory stimulation affects a particular region within the brain\* and initiates a wave of excitation which travels throughout the entire area around about the region. This irradiation\* of the excitation is only temporary, and is followed by a return of the wave to the point of origin. The return of the wave of excitation is called concentration\*. Around this point of final concentration of energy is induced the *inhibitory process*. Inasmuch as concentration requires a longer time than does irradiation, discrimination\*, which gives rise to selective responses, depends upon the induction of inhibition within the area around the concentration point in the brain. Generalization\*, on the other hand, can be accounted for in terms of the irradiation of the excitation wave over the whole brain area.

Although these neuro-physiological principles of irradiation and concentration have been severely criticised as too hypothetical, Pavlov has used them to explain many phenomena. Sleep, for example, is said to be an extreme degree of irradiation of the inhibitory process throughout the brain-cortex. The psychoneuroses\* are held to be due to a clash between excitatory and inhibitory states. Whichever process is dominant determines whether the animal, behaving abnormally\*, will show extremely lethargic (inhibitory) or hyperexcitable (excitatory) reactions. It must be remembered that these principles are inferences based upon observations of human and animal subjects in conditioning experiments\*. A major criticism of this theory is that conditioned\* responses may be established in the absence of the cerebral cortex, although Pavlov (1927) held the brain-cortex to be essential for this type of learning. Culler and his students have shown that animals without the cerebral cortex are capable of learning by conditioning. This finding raises the question of the validity of Pavlov's physiological interpretation.

A second group of theories offered to account for learning by conditioning are primarily *psychological* in nature. To account for classical conditioning (Pavlovian type), the *principle of substitution* is used. This principle holds that the CS becomes associated with the unconditioned stimulus (UCS) by repetition. Note that substitution by way of simultaneous or successive presentation of the two stimuli is another way of stating the



principle of contiguity\*, used by Aristotle and others to account for associative\* learning among memories\* and ideas\*. It is now obvious why conditioning is often said to be a new term for an old phenomenon. To account for the acquisition of less specific conditioned responses of the instrumental\* types, the principles of effect\* and expectancy are applied. When the animal learns to escape punishment by reacting adaptively in a generalized way, Thorndike's concept of satisfyingness is applied. The animal learns to avoid that which is annoying and to approach that which is satisfying. Inasmuch as Thorndike has modified the law of effect by recognizing that annoyers do not always result in elimination of incorrect responses, the principle of expectancy has been formulated. When the animal learns to react adaptively to a clue which serves as a signal for the approaching punishment, this principle is applied. It is inferred that the subject anticipates on the basis of previous trials, the approaching electric shock and so reacts prior to its application. Some call this process of anticipation "sign learning."

Learning by association\*, by trial\* and error, and by conditioning\* are thus merely different ways by which man and other animals learn to adjust to the demands of their particular environments. Under certain conditions one type of learning goes on, while under other circumstances another type appears. That these ways of adapting to new situations have several principles in common has already been indicated.

### TRANSFER\* OF TRAINING

Once man has learned, to what extent does he use his learning in new situations? This practical question has received two different answers in historical retrospect.

First, in the 18th and 19th centuries many believed that man's learnings were transferred in a broad and general way. It was believed, prior to the dawn of experimental psychology, that training in learning, memorizing, judging, and reasoning improved the faculties or powers located in the brain so that these powers were permanently increased. This belief was based upon the presently rejected theory of mental faculties (faculty\* psy-

chology). In education, believers in the general transfer of all learning emphasized the importance of memorizing, reasoning, and other mental activities because these activities were thought to improve and discipline the mind. This conception is known as the doctrine of formal\* discipline. This notion long influenced educational theory and practice. In fact, even up to a few years ago, certain subjects were taught in our schools because "they trained the mind." The early non-experimental concept as to the transfer\* of what one has learned was, therefore, phrased in terms of a broad general application of old learnings to new situations. By specific practice in memorizing man was assumed to memorize everything else in a superior fashion as a consequence of his practice.

Second, the more modern answer to the question of transfer comes as a result of experimentation. William James\* (1890) and Thorndike\* and Woodworth\* (1901) performed classical studies of the effect of practice on memory\* and on perceptual judgments\*, with results which cast doubt upon the doctrine of formal discipline and the theory of mental faculties. They found that transfer from situation A to situation B might be positive\* (that is, facilitate the learning of B) to a degree; negative\* (interfere with the learning of B) to a degree; or zero\* (have no effect upon the learning of B). These investigators and many others have shown by using the equated control\* group method that learning itself is more specific than general, and that transfer of training is far less general and broad than was once assumed by the early proponents of faculty\* psychology and formal\* discipline. The findings indicate that the teaching of any subject cannot be justified scientifically merely on the basis of "training the mind."

Selected results from studies of transfer\* follow.

First, transfer of training cannot be limited to include only information previously acquired. The term must also include attitudes\*, interests\*, prejudices, and techniques which can be carried over from situation A to B as readily as information. Clearly, one's recently acquired interest in physiology might be expected to function in the study of a second course and hence

facilitate its learning. So, too, those who learn to study correctly in beginning psychology may well be expected to transfer this skill to the study of history.

Second, the method of instruction is known to influence the nature and the degree of the carry over. In Latin an emphasis upon the derivations of English words by the teacher will increase the transfer of information from Latin to English. An emphasis by the teacher in agriculture upon the applications of the subject matter to farming will result in increased positive\* transfer.

Third, more capable students are known to transfer more from situation A to B than the less capable. The brighter students appear to perceive a larger number of relationships. How well the students have learned the material is also a factor in transfer. Incompletely learned material will soon be forgotten and so will not be transferred.

Fourth, studies of brain localization\* of function have failed to support the notion of separate functional areas in the brain for memory, reasoning, learning, and judging. Lesions\* (injured areas) located in any area of the brain have been found by Lashley to interfere with the learning and retention of numerous habits\*. His theory of equipotentiality\* of cortical\* tissue is a statement of these observations. (See Chapter Five.)

The question as to how transfer of training from situation A to B occurs has been answered by the formulation of three theories. *Thorndike* proposed the theory of identical\* elements (components) to explain the nature and degree of transfer. By this is meant the existence of components common to both situations A and B. Learning in situation A will facilitate learning in B because of these common elements. The absence of identical elements, depending upon the nature of situation B, would result in either negative\* transfer or absence of transfer. Judd\* has proposed the theory of generalization\* to account for carry over. Transfer, for him, depends upon the subject's understanding, his generalizing, and his applying principles and skills previously learned to a wide range of new situations. Judd holds that to increase positive transfer the student must be required to generalize and to apply his skills and information. Finally, the

Gestalt\* psychologists account for transfer of training in terms of the principle of configuration\*. Man responds to patterns of stimuli and man learns as a total organism. The entire neuromuscular system is modified by learning in situation A. The entire system, therefore, determines how man will react while learning situation B. If the parts of situations A and B are similar in some degree, response patterns will be transferred because the whole influences the function of the parts. The whole organism learns. Patterns of response are transferred as a consequence of the initial learning.

Final answers concerning the explanation of transfer of training are not yet available. Additional experimentation to test the three theories discussed above is needed.

## HABITS

Any habit\* is a well learned response which is elicited on a relatively automatic level and with a low degree of conscious awareness. Although some have included only locomotor\* reactions in their interpretation of habits, others more often have stressed the well nigh all-inclusive scope of habit patterns in everyday life. Our attitudes\*, interests\*, ways of thinking, adjustment\* mechanisms, ways of solving abstract problems, may all become habitual under appropriate conditions. The functions of habit, thus conceived, are those of economy in action and of personal and social stability.

Habit patterns are characterized as follows. They are automatic reactions requiring low degrees of voluntary\* attention and of conscious control. They are *stereotyped* reactions, since they are relatively stable and fixed responses more readily elicited under conditions of fatigue\* and emotion\* than are non-habitual patterns of response. They also possess inertia\*, or show resistance to change. Human habits persist and become more and more fixated\* with each repetition.

Two points of view once prevailed concerning the advisability of forming habits. Rousseau (1712-1778), the French educator and philosopher, stressed the need for the acquisition of a single habit, that of forming no habits at all. For him habits merely interfered with man's inherent capacity to appreciate nature and



to experience the good things in life. William James\* (1842-1910) on the other hand, held that habits are the "fly-wheel of society," and, as such, should be acquired by man in his early years, the better to lay a bulwark for the future. Modern mental\* hygienists and social\* psychologists are in agreement with James. They emphasize the need for the early and continued acquisition of a series of serviceable habits for the facilitation of man's adjustment to the routine activities of everyday life.

To alter one's habits the principles of learning must be applied. Man must go about selecting a personally and socially acceptable substitute response to supplant the undesirable one. Stimuli which elicit the old habit must by man's conscious effort and persistence come to elicit the more desirable response. Thinking before acting, in the early stages of this program of substitution, will aid, inasmuch as this procedure will allow time for substitution. A long period of practice is essential, since the old habit has had numerous repetitions. In the background of habit modification is, of course, man's desire for change. Without this motivation\*, habit alteration is impossible.

Knight Dunlap recently reported that in certain motor habits, such as typewriting, man can eradicate the wrong reactions by deliberately practicing the wrong ones. Thus, Dunlap selected certain words which he often typed incorrectly. He practiced them incorrectly while repeating to himself the words "this is wrong." In a test situation, he observed greater improvement in accuracy of typing than he noted when the correct forms were practiced from the start of the control\* experiment. This disruption of undesirable motor\* habits by the method of practicing the wrong habits he called the Beta\* Hypothesis. The application of the method to everyday habits should never be attempted except under the close supervision of the psychologist. It is to be noted that the Beta Hypothesis is in agreement with Thorndike's\* modified principles of effect and exercise (use).

The formation and the disruption of habits thus depend upon the principles of learning. Man can, if he wishes, make his habits his allies rather than his enemies, as emphasized earlier by William James (1890).



## FACTORS WHICH INFLUENCE MAN'S LEARNING

1. *Motivation\**. Without needs and wants man and other animals do not learn. Up to a certain optimal level of motivation, which depends both upon the subject and the level of difficulty of the task, the stronger the motivation the more rapidly does learning occur. Human subjects, therefore, if they are known to be equal in ability to learn, may differ in the speeds with which they acquire new material. They may differ because one is more strongly motivated than another. This statement is illustrated by the fact that young men and young women who have selected their vocations are generally more efficient in college than those students who have not as yet selected their life work.

2. *Age*. At one time children were believed to learn much more rapidly than adolescents and adults. Studies have shown this notion to be false. Older children and adolescents learn more rapidly than do younger children. The ability to learn, of course, is closely related to the mental\* ages of the children, adolescents, and young adults who acted as subjects in these experiments.

The learning ability of adults between the ages of twenty and seventy years has been studied by Thorndike\* and others. The subjects learned a wide range of different tasks which included motor\* skills as well as abstract and concrete verbal\* materials. Thorndike reports that man reaches the peak in his ability to learn during the early twenties. The decline in learning ability is slight, though noticeable, during the thirties and forties. Between fifty and sixty years of age the adult is likely to show a more pronounced decline in ability to learn new skills and other materials.

3. *Drugs\**. In a well controlled study of the *immediate* effects of smoking upon learning efficiency Hull (1924) found that the performances of his experimental subjects were not markedly interfered with. No data are available concerning the question of the effect of smoking tobacco over a long period of time upon learning. Life insurance companies, however, have reported that non-smokers generally live longer than smokers. Hollingworth\* (1923) has investigated the effects of alcohol\* upon learning efficiency. This *depressant* drug induces negative effects upon

learning in general. These effects are proportional to the amount of alcohol ingested by the subject. In another study Hollingworth (1912) studied the effect of *caffeine* upon the performances of two groups of subjects, the control and the experimental groups. Inasmuch as caffeine is the active ingredient in coffee, tea, and certain soda-fountain drinks, its effects should be of practical importance for many persons. His data showed that this drug, when administered in dosages ranging from two to six grains, was accompanied by noticeable increase in level of performance in typing, tapping, arithmetic calculations, and the cancellations of letters. This beneficial effect was observed to last from two to four hours. Larger dosages, on the other hand, interfered with the motor\* co-ordination of the subjects as well as with their sleep.

4. *Loss of sleep.* Various studies which measured man's efficiency after a period of fifty hours of wakefulness indicate that the level of performance is not significantly interfered with. The evidence shows, in addition, that the subjects put forth more effort in order to maintain this level. Prolonged insomnia, however, is not conducive to the maintenance of normal output. Sleep is essential for efficient learning.

5. *Ventilation and illumination.* For efficient learning the student should study in a room in which the air is in circulation and in which the temperature is about 70 degrees F. Good lighting is important in efficient study. Indirect lights are superior to those whose sources are direct inasmuch as the illumination is usually more diffuse and uniform. Uniformity is more important than intensity, since the eye adapts readily to changes in intensity. Daylight as well as artificial light similar to daylight yields its returns in efficiency as a source of illumination.

## TEST QUESTIONS

A. *True-False Statements.* Study each statement and decide as to its truth or falsity.

1. Learning continues in the absence of motivation.
2. Learning is unrelated to the stage of development of the learner.

3. Precocious training in motor skills before a child is ready to learn results in permanent gains in performance.
4. All overt responses are learned.
5. Thorndike is a pioneer investigator in the psychology of trial-and-error learning.
6. There is no single, typical learning curve.
7. When errors per trial are plotted on a graph the learning curve is ascending rather than descending in direction.
8. The Law of Use is offered to account for fixation in trial-and-error learning.
9. No motivation is needed when man learns by insight.
10. In instrumental conditioning the UCS is always applied on every trial, as a reinforcing agent.
11. Delayed and time conditioned reactions depend upon the procedures used to establish them.
12. Disinhibition means inhibition of inhibition.
13. Conditioning is a useful method for the determination of sensory and discriminatory acuity among animals.
14. Experimental neuroses cannot be induced by use of the conditioned response technique.
15. Equivalence among stimuli is demonstrated by the phenomenon of sensory generalization.
16. Transfer of training is known today to be general and broad.
17. Only information is transferred from one situation to another.
18. Less capable students show greater degrees of positive transfer than do the more capable.
19. The contention that man should form no habits at all is psychologically sound.
20. Negative transfer means that original training facilitates the learning of a later problem.
21. Perceptual reorganization is a characteristic of learning by insight.
22. Learning means that man's behavior has been modified as a consequence of experience.
23. Lightning is associated with thunder. This statement is an illustration of the principle of contiguity.
24. Reduced cues are fractions of original stimulating situations which serve to reinstate past experiences by way of memory.

25. Thorndike studied the trial-and-error learning of animal subjects in mazes and puzzle boxes.
26. Alcohol is a depressant drug in its effect upon behavior.
27. The x-axis is the base line of any graph.
28. The x-axis is to the abscissa as the y-axis is to the ordinate.
29. Most people learn at the same rate.
30. If man is very strongly motivated the physiological limit can be exceeded.
31. Periods of no improvement in learning are called slumps or plateaus.
32. Learning by conditioning is a new term applied to an old fact.
33. Excitation and inhibition are the two physiological processes assumed by Pavlov to account for learning by conditioning.
34. The doctrine of formal discipline is accepted today by modern educators.
35. Small dosages of caffeine reduce man's efficiency in typewriting and in calculation.
36. Intensity in illumination is more important than uniformity for efficient study.

B. *Completion Statements.* Read the incomplete statements and decide on the words that would complete each statement.

1. Man is able to solve \_\_\_\_\_ difficult problems than other animals.
2. Man's survival is \_\_\_\_\_ dependent upon his to profit from \_\_\_\_\_ than is the survival of other animals.
3. Man learns when he is \_\_\_\_\_ to learn and when he is \_\_\_\_\_ enough to profit from experience.
4. Man learns not only motor skills but also \_\_\_\_\_ and \_\_\_\_\_ .
5. The four techniques by which man acquires new skills and ideas are called (1) \_\_\_\_\_ ; (2) \_\_\_\_\_ ; (3) \_\_\_\_\_ ; (4) \_\_\_\_\_ .

6. \_\_\_\_\_ four descriptive laws of association are today included within the two laws of \_\_\_\_\_ and \_\_\_\_\_
7. Four characteristics of trial-and-error learning are (1) \_\_\_\_\_ ; (2) \_\_\_\_\_ ; (3) \_\_\_\_\_ ; (4) \_\_\_\_\_
8. Progress in any learning experiment may be quantified in terms of \_\_\_\_\_ required to learn, the number of \_\_\_\_\_ or \_\_\_\_\_ made during each practice interval.
9. Learning curves are usually of one of two general types. These are called \_\_\_\_\_ and \_\_\_\_\_ curves.
10. When a person has had practically no previous experience with a task to be learned, the shape of the learning curve is likely to be \_\_\_\_\_
11. The law of \_\_\_\_\_ is offered to account for selection of the correct response in trial-and-error learning situations.
12. Three explanations for the presence of plateaus in the learning curves based upon complex motor skills are: (1) \_\_\_\_\_ ; (2) \_\_\_\_\_ ; (3) \_\_\_\_\_
13. Thorndike's three laws of learning formulated early in the twentieth century are called the laws of \_\_\_\_\_ , \_\_\_\_\_ , and \_\_\_\_\_
14. The law of \_\_\_\_\_ has been modified inasmuch as experiments have shown that man does not always eliminate responses which are annoying to him.
15. The law of \_\_\_\_\_ has been modified by Thorndike inasmuch as experiments show practice does not always result in \_\_\_\_\_ of the correct response.
16. A child should be physically and mentally old enough to learn at his optimal rate a particular task before he is required to learn this act. This is an illustration of the law of \_\_\_\_\_



17. The principle of exercise is beneficial in learning by the trial-and-error procedure provided between the items is experienced by the learner.
18. As a consequence of perceptual reorganization the gap between the goal and one's motives and performances is closed. This is an illustration of the principle of .
19. Learning by conditioning includes the and types of experimental arrangements.
20. A conditioned stimulus is also called the or stimulus.
21. The unconditioned stimulus is called the or stimulus.
22. The conditioned response is not with the unconditioned response.
23. The conditioned response, once established, must now and then be followed by the unconditioned stimulus to prevent .
24. The simultaneous presentation of the CS and the UCS is called .
25. Psychologically, learning by conditioning of the classical type has been accounted for in terms of the principle of .
26. Transfer of training may be either , or in amounts.
27. Thorndike has proposed the theory of to account for transfer of training.
28. The principle of is used by the Gestalt psychologists to account for transfer.
29. Characteristics of habitual responses are (1) , (3) (2)
30. Dunlap has shown that certain motor habits in typing can be altered by practicing the . This observation he has called the Hypothesis.
31. An adolescent with a mental age of ten will learn than a child with a mental age of seven.



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## CHAPTER EIGHT

### *Man's Affective Life*

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#### THE AFFECTIONS

MAN not only knows what goes on about him (cognition\*), but he may also experience as pleasant or unpleasant, or as emotion\* inducing, that which he perceives. The emotions, moods\*, feelings\*, sentiments\*, temperament\*, and, to a degree, interests\* and attitudes\* compose the affective life of man. Affection is, therefore, a broad term including much more than is popularly assumed. The psychologist studies these phases of the affective life because they play predisposing roles in influencing our behavior. He studies affection for, by so doing, he obtains added insight into one trait of personality, namely, emotionality.

#### HOW THE EMOTIONS ARE STUDIED

Man's emotional behavior is studied from three different approaches.

First, the psychologist studies the kind and degree of responses made to stimuli which the subject perceives as fearsome, dangerous, or anger-inducing. These responses, when classified, are designated as overt\* activities leading to (1) attack; (2) approach; (3) retreat; (4) resignation. The responses are studied by the objective method of observation.

Second, emotion may be studied by means of introspection\*. The subject describes his experiences during the "stirred up condition of the organism" called the emotion. These reports, when

analysed, become the basis for the statement that the primary emotional states experienced by man are *anger, lust, elation, fear, and grief*. All others are composites, so to speak, of these more basic patterns. Experiences of anger, if not voluntarily controlled, lead to attack responses. Elation and lust may result in approach reactions. Fear\* experiences lead to escape and retreat. Grief, on the other hand, results in resignation in face of the stimulus\*. These escape and attack reactions indicate why some writers, particularly Charles Darwin, have spoken of the usefulness (biological utility) of strong emotional states for the preservation of life. It is to be noted that, since the method of introspection is not completely satisfactory because subjective observation of an emotional experience may destroy that which is being observed, a third method for the study of many covert\* emotional reactions has been devised.

Third, emotional behavior may be studied by the physiological\* psychologist, inasmuch as numerous covert or *implicit* responses occur during the emotional state. These changes are as follows:

1. *Changes in circulation.* During an emotion there occurs an increase in pulse rate and in blood pressure which can be accurately measured respectively by the sphygmograph\* and the sphygmomanometer\*. A pistol shot, giving rise to a "startle pattern," increases the number of heartbeats per second.

2. *Changes in respiration.* During emotionalized responses the length of time spent in normal inspiration (inhaling) and in expiration (exhaling) changes. Thus, a ratio in time values of  $I/E$  can be obtained to express these changes in breathing. The pneumograph\* is used to record respiratory variations during emotion.

3. *Changes in digestive activity.* Strong emotion is not conducive to normal digestion. Pleasant moods, on the contrary, aid in the peristaltic or "churning" action of the stomach's smooth muscles. These results have been disclosed by X-rays which photograph the action of the stomach tissue of those animals emotionally aroused shortly after feeding.

4. *Changes in the action of the glands.* Primitive peoples once

used the "rice test" as a determinant of guilt. Today this test is known to have a physiological basis inasmuch as during fear emotion the salivary glands of the mouth secrete less saliva. It is thus possible that a guilty person would not be able to chew and to swallow rice as readily as those who are innocent. In addition to the decreased activity of the salivary glands, adrenin\* is secreted from the medulla\* of the adrenal\* glands, insuring more rapid coagulation of the blood and bringing about increased secretion of blood sugar by the liver. Adrenin also aids in speeding up circulation, thereby facilitating the rapid removal of wastes as well as the accumulation of an adequate supply of food materials for the contracting skeletal muscles.

Measurements of these glandular changes that occur during emotional reactions are made by means of blood and urine analyses. The *sweat glands* of the skin pour out their secretions particularly upon the palms of the hands and the soles of the feet. It has been maintained by some that this increase in perspiration aids in the grasping of objects for self-protection. The increased moisture of the skin *lowers* the resistance of the body surfaces to the passage of a very weak electric current. The change in skin resistance during emotional behavior is indicated by the galvanometer\*, a sensitive instrument used in the measurement of very weak electric currents. Accordingly, the reaction of the skin to the passage of the current is called the psychogalvanic\* or skin\* reflex (PGR). Changes in the PGR are believed to be related to the intensities of the various emotional experiences. The magnitude of the PGR, in addition, usually changes when the subject is placed under other stimulating conditions. Not all stimuli, therefore, arouse equally intense emotional responses within the same subject. The magnitude of the skin reflex, however, tells us nothing about the pleasantness or unpleasantness of the experience. The fact that the PGR varies in states of fatigue, exercise, and illness indicates that these conditions possess certain similarities to emotional reactions. It shows that emotion and exercise, for example, must be differentiated on grounds other than the purely physiological.



## ARE THERE BODILY CHANGES SPECIFIC FOR EACH EMOTION?

It was once assumed that changes in the viscera (large organs in the body cavities) and in the skeletal muscles are specific for each emotion. If this were true, measurements obtained by various instruments would yield changes of specific magnitudes for one's fear reactions and still other specific changes for anger, lust, and grief. Numerous studies have been carried out to test this hypothesis\*. The results have indicated that no specific physiological pattern for each emotion exists. The analyses merely show that "something is going on" within the organism. Data on the respiratory, circulatory, digestive, muscular, and glandular changes tell us nothing about the specific emotion experienced. Indeed, these measurements do not differentiate between emotion and the bodily changes which accompany muscular exertion, as in rowing a boat. The emotion, as an experience, is more than the sum of the bodily changes.

Related to the question of internal changes during an emotion is the problem of skeletal muscle patterns (as in the case of the face muscles) and our use of these muscle patterns in "reading" the emotional reactions of those about us. Can we judge the emotion portrayed in photographic poses? Can we judge an emotion shown in the facial expression without knowledge of the inducing stimuli? Studies of these questions have given, in general, consistently negative answers. Judges, presented with photographs of the face, have been found unable to make accurate judgments of the emotions portrayed by a talented actress. Further, judges, if they do not know the stimulating situations involved, are unable to identify correctly the emotional responses of infants. When, however, the stimulating situations (dropping, hunger, restraint) are known to the judges, the accuracy of their judgments is increased. We may conclude that knowledge of the stimulus is an important factor in the identification of the emotions. Accordingly, psychologists believe that any classification of the emotions into well-defined groups is too arbitrary to be of great practical value. The only acceptable classification would have to be constructed in terms of the total stimulus-response

situations, thereby permitting as many classes of emotions as there are situations. At best, the only advantage to be gained by any classification of the emotions would be the greater ease in discussion and clarification of the subject. For this reason the primary emotional patterns have been said to be anger, lust, fear, elation, and grief.

In the absence of specific muscular and visceral patterns, the question arises as to how it is that one's close friends are able to identify one's emotional reactions. Long acquaintanceships familiarize one's friends with the situations which induce habitual affective responses. Familiarity with the person and knowledge of the stimulating situation make this prediction possible among intimates.

### THEORIES OF EMOTION

*First*, early students of emotional behavior stressed only its conscious aspects. Little attention was paid to the skeletal and physiological changes which are now known to accompany these conscious experiences. These writers said, for example, that we run because we are afraid.

*Second*, investigators tended to identify the bodily changes, as perceived by us, with the emotion. William James\* (1884) and Carl Lange\* (1885) held that the perception\* of the exciting situation induces visceral, circulatory, and skeletal muscular reactions. These reactions, in turn, send nerve messages to the brain, and the perception of the messages is identified with the emotion. For example, the perception of one's physical changes during flight constitutes the emotion of fear\*. We are afraid, in a sense, because we run. This theory necessitates the presence of specific visceral and muscular patterns for each emotion. We have just seen that specificity of this sort does not exist. According to the James-Lange\* theory, then, animals, which, as a result of surgical operation, lack certain connections with the central nervous system would not experience an emotion. Studies of operated animals, to the contrary, have indicated that emotionalized behavior is very apparent among such animals. No method, of course, can tell the psychologist whether the animal's experi-

ence in those cases is identical with its emotional experience prior to the operation.

A *third* interpretation of emotion is that presented by Woodworth\*. For him the perception of the emotion-inducing stimulus leads, first, to a conscious goal-set, such as to flee, and second, to body changes which prepare man for an emergency (attack, retreat, or approach). Thus, the difference between emotion and exercise, both stirred up conditions of the body, is one of mental attitude\*.

*Fourth*, and most recently, Cannon\*, Bard, and others at Harvard University's Physiology Department have investigated the function of the autonomic\* nervous system in emotionalized behavior. This division of the nervous system is only to a slight degree under one's control and is known to regulate the bodily functions, such as digestion, respiration, and circulation. This "autonomous unit" is divided into two motor or efferent\* segments called the sympathetic\* (middle portion) and the para-sympathetic\* or cranial-sacral\* (both extremes). Figure 23 illustrates in a general way the relations and the functions of these segments. Cannon has shown by operative procedures on lower animals that strong emotions (such as anger and fear) are made possible by the sympathetic\* branch which prepares the organism for an emergency and so intensifies the emotional response. The para-sympathetic\* segment, on the other hand, functions during milder states of pleasant well-being and acts as a check on the sympathetic portion. To illustrate, the sympathetic curtails digestion and raises the blood pressure. The cranial-sacral\* aids in digestion and lowers the blood pressure. The action of these two divisions of the autonomic system are thus antagonistic.

Cannon\* has also shown that animals from whom the sympathetic divisions have been surgically removed, still react to stimuli in emotionalized ways. This conclusion agrees with the observations made on the spinal dog by the English physiologist Sir Charles Sherrington\*. That bodily changes are not essential for emotional experience, as James and Lange maintained they were, is further indicated by Cannon's studies of the effect of injections of adrenin\* into the bloodstream of human subjects. Adrenin is normally secreted by the medulla\* of the adrenal\* glands follow-

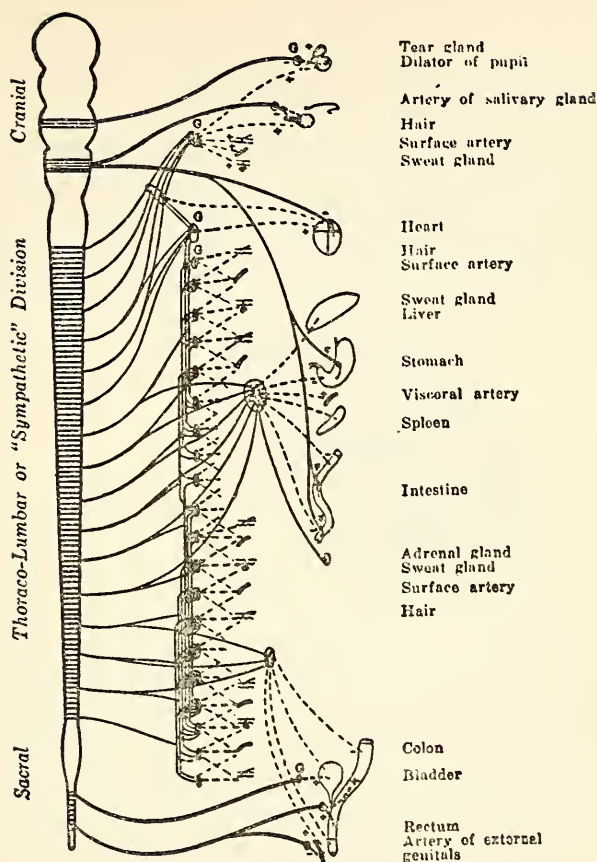


Fig. 23. Diagram of the divisions of the autonomic nervous system. Note that the sympathetic division is anatomically related to the middle (thoraco-lumbar) segments of the spinal cord. The cranial-sacral division (parasympathetic) is related to the brain stem and the lower segment of the spinal cord, respectively. The cranial-sacral division is in the heavy lines. The plus sign indicates a facilitative effect, while a minus sign represents an inhibitory effect. (Reprinted with permission of the Appleton-Century Company from Cannon, *Bodily Changes in Pain, Hunger, Fear and Rage*, 1929, p. 23.)

ing their activation by the efferent\* nerves of the autonomic\* system. If adrenin is essential for emotional reactions and for emotional experience as well, injections of the drug should induce synthetically these reactions. Introspective\* reports by human subjects\* have shown the presence of "stirred up" bodily states, but no true emotion\* was experienced. The experiences of the subjects could not readily be introspectively differentiated from those experienced during exercise\* and fatigue\*.

These conclusions led Cannon and Bard to study the role of the brain\* in emotional behavior. By surgical removal of various

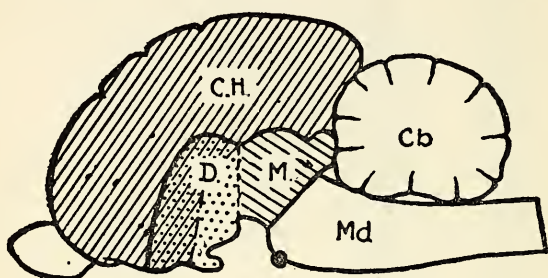


Fig. 24. Diagram of a section through the middle of the cat brain. The rage response was still exhibited with the removal of the brain areas represented by right-to-left crosshatching in the figure. Removal of brain tissue posterior to these regions was followed by no rage responses in the presence of rage-inducing stimuli. For these reasons Cannon and Bard believe the hypothalamus essential for emotional expression. CH refers to the cerebral hemispheres; D to the diencephalon or thalamus; M to the mid-brain; Cb to the cerebellum; Md to the medulla. (Reproduced with permission of D. Appleton-Century Co., from Cannon, *Bodily Changes in Pain, Hunger, Fear and Rage*, 1929, p. 247.)

parts of the brain of a cat, they found that the hypothalamus\*, a small region in the brain\* stem\*, was essential for the cat's display of rage in the presence of a strange dog. The cerebrum\*, on the other hand, was not essential. Its removal merely enhanced the excited behavior of the cat. By virtue of numerous findings such as these, Cannon formulated his Emergency\*



Theory of the Emotions. Strong emotion, he believes, is the result of an interplay of nerve messages between the cerebral\* cortex\* and the thalamus\*. Sensory messages from the sense\* organs activate both the thalamus and the cortex. Messages from the thalamus induce bodily changes in the muscles and organs of the lower abdomen (viscera\*). Information concerning these bodily changes is relayed to the brain and reinforces the emotional state already induced by the exciting stimulus\*. The difference, then, between emotion and exercise is in terms of the interpretation given by the subject to the stimulating situation. Historically, Cannon's theory to account for the strong emotions is the most recent and serves to modify and amplify earlier explanations.

### THE COMPLEX

Popular writers make frequent use of the "complex\*." The term has been defined by Hart<sup>1</sup> as "an emotionally toned group of ideas." Just as one reacts openly in emotionalized ways, so, too, may one's thoughts be emotionally colored. Experiences may leave ever so vivid after-effects. When these experiences are recalled at a later date, the emotional accompaniments experienced earlier may, too, be reinstated. From a series of these emotional experiences, complexes of at least three general sorts may develop. If the urge to sexual satisfaction is thwarted, ideas tinged with this emotion are often reinstated by reduced\* cues. This is known as a sexual\* complex. It serves as a "mental\* set," often leading one to interpret ordinary conversation from a particular point of view. If the urge for security (economic and social) is frustrated, a fear\* complex (poverty, loss of prestige, and of belongingness to the group) may occasionally result. If the urge to superior performance is blocked, the individual may develop an inferiority\* complex. In each instance, the individual's behavior is interfered with, since the mental set dominates his thoughts and actions. These types of complexes frequently influence man's reactions without his understanding the true cause. Indeed, complexes may so determine one's behavior that they become obvious to almost every one else.

<sup>1</sup> B. Hart, *The Psychology of Insanity*. New York: Macmillan, 1937. Pp. 191.

Alfred Adler\* (1870-1937), a student of the psychoanalyst\*, Sigmund Freud\*, has emphasized the role of the inferiority complex as a determiner of human adjustment and maladjustment. An urge to domination and power, he assumed, was inherited in its basic essentials, and has, therefore, led all men to aspire to superiority. Although his interpretation is not generally approved today, the complex\* is accepted as an acquired way of thinking, which, if present, will predispose one to act in rather prescribed ways. We must remember, however, that not all "groups of emotionally toned ideas" are considered morbid and abnormal\*. A stamp collector is not considered abnormal even if he makes a practice of searching in waste baskets. The social criterion of normality is thus in evidence.

Determination of the content of the complex by means of word association\* tests was first attempted by Carl G. Jung\* in 1910. He arranged a list of 100 stimulus words some of which were critical and some indifferent. These were presented individually to the subject who was instructed to respond by saying the first word which occurred to him. Various complex\* indicators were discovered, each of which could be used as a cue\* to the content and the intensity of the emotionally toned group of ideas. Some of the indicators are as follows. (1) The average time in seconds required to respond to indifferent stimulus words was measured. If the subject required considerably longer than usual to respond to a particular word, this was evidence that a word substitution had taken place. This stimulus word was now taken as critical, since a longer than normal time was taken for verbal reaction. Occasionally a response was so rapid that a shorter than normal reaction\* time obtained. This, too, Jung considered a cue to the content and strength of the complex, inasmuch as the word probably had been "saved up" for the occasion. (2) When one response word occurred several times in the list of reactions to different stimulus words, the subject was said to persevere\*. This carry-over of responses acted as a cue to the discovery of complex content. (3) When the response was radically different from those given by most people to the stimulus word, the response was called idiosyncratic\*. (4) Occasionally,

a stimulus word induced no verbal response at all. This was called the mental block\*.

It is clear that emotional difficulties may be analyzed by means of the word-association method among others. Knowledge obtained by such methods aids the clinical psychologist in directing the subject toward more personally and socially satisfying goals. Since those with complexes frequently think about their real or imagined inadequacies, fears and sex problems, the free\* association procedure can tap these habitual ways of thinking. The method has also been used with some success for the detection of crime and guilt, inasmuch as the recency and vividness of the guilt experience may be mirrored in unusual verbal responses.

### EMOTIONAL BEHAVIOR AND LEARNING

John Watson\*, who studied the behavior of infants, reported (1929) three basic, inborn types of emotional responses which he called *fear*, *rage*, and *lust*. Fear responses were induced in infants by loud sounds and loss of bodily support. Anger responses were stimulated only by restraint of physical movement. Lust responses resulted from light stroking of the sexual regions of the body. Although there is some question as to the innateness of these specific patterns, Watson's studies do indicate that the human infant during the first year of life is sufficiently developed to react emotionally. As the child grows older he learns more and more what to fear, or what to be angry about. Thus, if we are to understand the emotion of the adult, the factor of learning must be added to the factor of physical and mental development.

The method by which one learns to react in emotionalized ways is known as learning by conditioning\*. If two stimuli, one adequate (strong enough and emotion inducing) and the second inadequate for the induction of the emotion of fear, for example, are repeatedly presented at about the same time, the inadequate stimulus will eventually arouse the fear reaction. Thus, if a furry animal is presented as a desirable object to a child at the same moment that a loud sound is presented, the animal will eventually come to be feared. Indeed, the association between the object and the loud sound may become so generalized that many furry objects, other than animals, will be feared. Watson has main-

tained that the majority of our emotional reactions are the results of conditioning.

Within the last decade (1930-1940) important genetic\* studies of the emotional reactions exhibited by neonates to various kinds of stimuli have been carried out. Pratt, Nelson, and Sun (1930) have reported that not only the nature of emotionalized behavior but also its presence or absence depend upon the entire situation at the time the various stimuli\* are presented. If the infant, to illustrate, has just been fed, the stimuli Watson used to elicit the so-called innate\* emotional reactions\* no longer induce an emotional response. When the infant is hungry, however, fear and anger are elicited by numerous stimuli. In addition, a wide range of stimuli applied to different areas of the body evoke highly similar skeletal muscle responses. Specific emotionalized reactions during the first few months of life are not observed. Undifferentiated emotional responses, thus, at an early age appear closely related to the physiological needs at the moment.

With increasing age during the first year of life, however, the emotional reactions are more closely correlated with the nature of the stimulating object as well as with its point of application. It is not surprising, therefore, in view of this later finding, that the adult under emotional stress always responds with such expressions as "angry at," "in love with," or "afraid of." Adult emotional reaction with its experiential element is always tied to objects and events.

A second series of studies has been conducted by Bridges (1931). This Canadian investigator reports that the infant shortly after birth shows no specific emotional reactions, such as anger, fear, and lust. A wide range of stimuli induce random, diffuse, neuromuscular reactions best characterized as general "excitement." With growth\* and maturation\* of the neonate the more specific and readily identifiable emotionalized responses develop or individuate\* from the diffuse pattern of excitement. The evidence shows that infants exhibit fear and anger responses by the sixth month following birth. Affection\* is first observed at about the twelfth month. Recent evidence, thus, supports the conclusion that emotional patterns of behavior\* directed toward particular objects and events develop as a consequence of the combined



roles of maturation\* and learning\*. The neonate is provided, therefore, by heredity\* and by a prenatal environment with (1) a structure to react; (2) a capacity to grow and mature; (3) a capacity to undergo structural modification by the learning process. These findings support the conclusion reached by Watson concerning the important role played by learning in the genesis of emotional responses.

The studies reported by Pratt, Nelson, and Sun as well as those prepared by Bridges are in agreement with those conducted by the anatomist, Coghill (1929). In his detailed investigations of the embryonic development of *Amblystoma* (a species of salamander) Coghill finds that specific behavior patterns develop within an already existing integrated or total pattern of diffuse, generalized activity. These reactions acquire their specific patterns by means of the process of individuation\*.

Inasmuch as we learn to show or to inhibit our emotional responses in specific situations, so, too, may these emotional patterns be modified, or, in some instances, completely changed. Numerous methods for the control of emotional behavior have been suggested and have been tried with varying degrees of success. (1) Some have attempted to guard against the appearance of the emotion-inducing stimulus. This method has been none too successful, since it places too many restrictions upon the environment of the person. (2) Others have tried applying the adequate stimulus many times to acquaint the person with the feared object. This method, when successful, is usually a slow one. (3) Some people have tried to control an undesirable response by verbal assurances, by reasoning, and by ridicule. This method rarely works. (4) More recently, reconditioning\* has been tried and has been found more successful than the other methods. By means of this procedure the feared object, for instance, is gradually associated in time and space with a pleasant experience, such as eating. Day after day, to illustrate, the feared object is presented ever closer to the table at which the child is eating a favorite dish. Shortly the furry object and the food are associated pleasurably together. Responses to numerous other furry objects are modified, indicating the generalization of the retraining procedures to other objects and events.



## MOODS AND TEMPERAMENTS

The mood\* is the "left over" effect of an emotional experience. It is, therefore, often defined as a weak, though protracted, emotion. To illustrate, the "gay" and "black" moods are persistent after-effects of the emotional experiences of elation and anger respectively. Inasmuch as our emotional behavior depends upon the stage of our development as well as upon our opportunities for learning, it is little wonder that moods oscillate. These everyday fluctuations, however, should give us no great concern. When a mood appears to predominate throughout the life span we speak of this characteristic as the person's temperament\*. This means that the person characteristically exhibits to the observer a series of traits\* which are relatively constant over a long period of time. Thus, some people come to be known as "jolly" and others as "sour." To the degree that these moods and temperaments are influenced by the environment, then, to that degree may they be modified by training in emotional control.

## THE FEELINGS\*

The subjective experiences which accompany overt responses can often be described in terms of *pleasantness* (P) and *unpleasantness* (U). These affective attributes, or aspects of experiences, merely serve to describe rather than to explain. The "feelings," therefore, represent experiential aspects of any conscious state. They differ in degree from the very pleasant to the very unpleasant. These aspects of experience can be studied only by using the introspective\* method of observation. They must be described and reported by the individual who experiences them.

Several theories have been presented from time to time to account for the degree of pleasantness (P) and unpleasantness (U) which we experience. Selected ones follow. (1) P-U were once assumed to be inherited characteristics of sensory nerve\* messages. With the expenditure of considerable nerve energy, unpleasantness was experienced. With the expenditure of small amounts of nerve energy, pleasantness was perceived. Evidence from studies on nerve conduction do not support this theory. (2) P-U have been assumed to possess specific sense\* organs,

which, when stimulated by adequate physical energies, arouse these experiences. No such structures have been found by the physiologists. (3) A current theory formulated by Carr (1925) holds that states of unpleasantness and pleasantness are judgments\* based upon our past experiences in similar situations. This Judgmental\* Theory of Feeling is under active investigation at the present time. (4) A second current theory is that presented by Nafe (1924) who believes that pleasantness and unpleasantness correspond to or can be identified with bright and dull pressures. This theory, too, is a modern research problem. The explanation for P-U experiences is not yet available.

### SUMMARY

An emotion is defined as a stirred up condition of the organism. It is a total response of the individual. The emotion consists of the following three aspects: (1) the experiential; (2) the behavioral; (3) the physiological or organic. The experiential aspect is studied by using the Method of Impression\*. This procedure requires introspective reports which describe conscious states during an emotion. The behavioral and the physiological aspects of emotion are quantified in the laboratory by using the Method of Expression\*. This requires careful observation of what the person does as well as a study of what goes on within the body during emotion. Highly refined measuring instruments are often used to aid in this analysis. When the results obtained from the application of these two methods are compared, the conclusion is reached that man possesses numerous words, or symbols, such as *fear*, *anger*, *joy*, *grief*, for each of which verbal expressions no differential and specific physiological or organic pattern exists. Words, though they describe a person's experiences, possess no explanatory value. Words, describing emotional states, only provide for the social communication of our experiences.

The development of emotionalized responses has been studied. The neonate is known to exhibit diffuse motor\* reactions in response to a wide range of emotion-inducing stimuli. General "excitement" rather than a specific rage or anger pattern is characteristic of the emotions shown shortly after birth. Out from this total pattern of bodily response individuate, by virtue of the

combined role of learning\* and maturation\*, the more specific emotional experiences which the adult calls "rage," "love," "grief."

The term affection\* is a general one and includes emotion, mood, pleasantness, unpleasantness, temperament, sentiments. To the degree that interests and attitudes are colored by one's emotions and feelings, so, too, are they affective in nature. Affection is thus differentiated from the purely intellectual or "knowledge about" aspect (cognition\*) of human behavior.

### TEST QUESTIONS

A. *True-False Statements.* Read each statement and decide as to its truth or falsity.

1. Darwin has stressed the utility of man's strong emotions.
2. Without the use of instruments a covert emotional response cannot be observed.
3. The sound of a pistol shot is an adequate stimulus for the "startle pattern."
4. The pneumograph is used to measure changes in circulation during emotion.
5. The salivary glands secrete more saliva during fear than they otherwise do.
6. Only under conditions of strong emotion is the skin reflex apparent.
7. Emotion and exercise are alike in that both are stirred up conditions of the organism.
8. A marked deflection of the galvanometer reading is symptomatic of a highly pleasant experience.
9. The nature of an emotional experience can be read from the face by trained judges.
10. Classification of the emotions is more practical than it is accurate.
11. James and Lange identified organic changes with the emotional experience.
12. Sherrington reports that the decorticate dog exhibits reactions judged by the experimenter to be emotional in nature.
13. An intact cerebral cortex is essential for emotional responses.
14. Complexes are always morbid and abnormal in content.

15. Unusually long verbal reaction time is considered by Jung as an indicator of the nature of the complex.
16. Perseveration in speech is indicated when a verbal response recurs over and over.
17. The parasympathetic division of the autonomic nervous system prepares the organism for an emergency according to Cannon.
18. The hypothalamus has been found essential for the expression of emotional patterns of response.
19. Watson holds that fear, rage, and lust are inherited emotional patterns.
20. The transfer of a fear of rabbits to numerous other furry objects is an illustration of the generalization of a fear response.
21. Bridges reports that the neonate's single emotion is one of general excitement.
22. Coghill's study on *Amblystoma* is in disagreement with Bridges' findings on infant emotionality.
23. Ridicule of those who fear snakes is effective in helping them overcome the fear.
24. Mood and temperament are synonymous terms.
25. Our feelings are accounted for in terms of judgments, according to Carr.
26. The sympathetic and the parasympathetic divisions of the autonomic nervous system are antagonistic in their functions.
27. The autonomic nervous system is largely an efferent system.
28. The effect of increased amounts of adrenin in the blood is to decrease its coagulability.
29. Injections of adrenin into the blood stream of the normal person induce emotional experiences which cannot be differentiated from those accompanying the perception of a feared object.
30. Both maturation and learning play important roles in the development of emotional response patterns.

B. *Completion Statements.* Read the incomplete statements and decide upon the words that would complete each statement.

1. Man's affective life includes his (1) \_\_\_\_\_ ,  
 (2) \_\_\_\_\_ , (3) \_\_\_\_\_ , and  
 to a degree his (5) \_\_\_\_\_ .

2. The use of introspective reports in the study of emotional experience is called the Method of \_\_\_\_\_.
3. The four overt behavior patterns which may accompany emotional experiences are called (1) \_\_\_\_\_, (2) \_\_\_\_\_, (3) \_\_\_\_\_, and (4) \_\_\_\_\_.
4. To help us study man's affective life, man's emotional experiences have been classified into five primary types. These are (1) \_\_\_\_\_, (2) \_\_\_\_\_, (3) \_\_\_\_\_, (4) \_\_\_\_\_, and (5) \_\_\_\_\_.
5. Adrenin is a hormone secreted by the \_\_\_\_\_ gland located near the \_\_\_\_\_.
6. The rice test used by primitive peoples is physiologically sound because the \_\_\_\_\_ glands secrete \_\_\_\_\_ during fear.
7. The psychogalvanic reflex is quantified by the instrument known as the \_\_\_\_\_.
8. The sympathetic division of the autonomic system \_\_\_\_\_ digestion, while the parasympathetic portion \_\_\_\_\_ digestive processes.
9. Removal of the cerebral \_\_\_\_\_ in the cat \_\_\_\_\_ the animal's show of rage.
10. Three complexes, described in terms of their contents, are called (1) \_\_\_\_\_, (2) \_\_\_\_\_, (3) \_\_\_\_\_.
11. Alfred \_\_\_\_\_ holds that all men are motivated from birth by a drive for \_\_\_\_\_.
12. Three indicators used by Jung in the word-association method are called (1) \_\_\_\_\_, (2) \_\_\_\_\_, and (3) \_\_\_\_\_.
13. The basis for a feeling of inferiority may be either real or \_\_\_\_\_.
14. One advisable method to use in overcoming a fear is the \_\_\_\_\_ method.
15. Watson has shown experimentally that our emotional experiences \_\_\_\_\_.



and their patterns of expression are greatly influenced by learning of the response type.

16. The development of specific patterns of emotional response out from diffuse behavioral reactions of the whole organism is called the process of .
17. Bridges studied the development of emotional behavior in subjects, while Coghill, by training an , studied the development of locomotor activities in a species of .

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## CHAPTER NINE

### *Revived Experiences—Imagination and Dreams*

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#### KNOWLEDGE A COMBINATION OF PAST AND PRESENT PERCEPTS\*

ONE OF THE MOST STRIKING FACTS of mental life is the revival of experiences. Almost any object once seen may reappear in consciousness\* at a later date in somewhat the same form that it had at the time of its original appearance. This ability to live in the past as well as in the present is a fundamental characteristic of man, striking in itself and of the greatest importance for the development of knowledge and for the interpretation of the present. If we study in more detail the life of mind, we see that revived experiences not only are present when we are intentionally remembering but also are phases of what seems to be the mere sensing of the present.

*After-Images\* as Retention\**. We may consider first the possibility of retaining at all. Persistence of activity seems to be a function of all tissue. It is most evident in nervous structure—especially in the senses. If one looks at a bright light, one continues to sense, for a fraction of a second, a bright image\* which in a few seconds is transformed into a black image that persists for an appreciable time. The image of the same color or brightness is not ordinarily noticed, although its presence is shown by the fact that it mixes with other colors to produce intermediate colors. A rapidly rotating disk with sectors of different colors mixes the colors as effectively as does the superimposing of lights. This is due to the mixing of the after-image\* of one sector with

the actual image of the adjoining sector. These after-images last but a fraction of a second, but they demonstrate the existence of a trace left by the stimulation of the eye. Other senses show the same tendency, but the impression lasts a shorter time.

*Memory\* After-Images.* The sensory areas in the brain show a similar delay in the disappearance of any effect wrought upon them. Look for a fraction of a second at a sign or at a display in a shop window and you will be able to recognize objects after you have turned away. Expose a series of words for a fifth of a second in the laboratory, and the student will read them from a mental photograph, a second or so after they are covered. Similarly, when reading attentively, one may be spoken to without noticing and then become aware a second or two later, not only of the fact that one was spoken to, but also of what was said. This persistence of the impression is sometimes called a memory\* after-image or primary\* memory. It is regarded as much like the after-image in the sense\* organ, a persistence of the action after the stimulus\* has ceased to act. The maximum duration is usually but five to ten seconds. The vividness and fidelity of this image is a quantitatively accurate guarantee of readings of thermometers and other instruments, when the eye must be taken from the scale to guide the pen in order to record the reading. These memory after-images follow immediately upon the sensation\*.

*Memory Images.* Finally we have the true memory\* images. These recur after longer intervals than in the case of the memory after-images, sometimes years after. One may see an individual today and not think of him again until, perhaps, tomorrow an experience associated with today's event occurs, and then one will recall the individual immediately. After-image\*, memory\* after-image, and memory\* image are much alike in the qualities they possess. They differ primarily as to the extent to which there is continuity in time with the original impression, in the case of the two first images and discontinuity in the case of the third. Images constitute the great bulk of mental life. They are sometimes definitely like the original; sometimes, they only hint at it. In either case they furnish the basis for the recall\* of events, and for much of constructive thought and imagination\*.

*The Forms of Imagery.* The differences between individuals as to the senses they use for recall\* are frequently considerable. Some individuals use mainly visual sensations for the representation of events, others sounds, still others the kinaesthetic\* sensations or the sensations that are produced in the muscles as they contract. Occasionally, an individual will make great use of a minor sense. Zola was found on examination to have recalled odors definitely and frequently. His novels contain many references to odors. More than ninety per cent of students were found to use vision predominantly in recall. The remainder were rather evenly divided between those who showed a dominance\* in tones and those who used kinaesthesia\* most often. They were measured by asking them to recall definite events and then to describe the imagery they used in the process of recall. In these experiments some of the results were confirmed by giving tasks that require imagery of a definite kind. Success in the task is accepted as an indication of the possession of the imagery. Thus it is assumed that if an individual can spell a word backwards more quickly than another individual, he has better visual imagery. Or if he is told to picture a wooden cube painted red and then to think of it as cut into nine smaller cubes and, further, to state how many cubes will have paint on two sides, a prompt correct answer will indicate good visual imagery.

*Verbal and Eidetic Imagery.* Various studies have been made of the senses used in verbal\* imagery. These studies show that in the recall of words, audition and kinaesthesia are used about as frequently as vision. If one classes hearing and the motor means of recall together as inner\* speech, about two-thirds of all people think of words by reproducing the sensations from the muscles that they experience when they speak or hear themselves speak, and only a third reproduce the words as they would see them. Certain individuals, particularly children in their teens, have imagery, mostly visual, so vivid that the objects imaged appear to be actually present. The child traces the different parts of the object with his eyes, and sometimes projects them to different distances. These individuals are said to have eidetic\* imagery. A test sometimes applied for the possession of eidetic imagery is



to measure the size of the image, for the eidetic image seems larger for distant than for near projections.

*Mental Efficiency Dependent upon Type of Imagery.* Imagery modifies the capacities and the character of responses of individuals in many ways. Success in certain activities would be difficult without imagery suited to those activities. A musical composer would be handicapped if he had no memory for sounds, and an artist if he could not recall colors. Some statements that might seem probable about imagery have proved false when put to the experimental test. Thus, it is better to use the imagery that is best for the individual than to stimulate all possible senses at once as has been suggested. One experiment indicated that an individual might be able to remember better those materials perceived through a sense other than that of his prominent imagery. A visualist was found able to remember words spoken to him better than those which were shown in print. The effort of translating into seen words increased the clearness with which the words were recalled. One would think that a man who could play ten games of chess blindfolded would need to have vivid visual imagery. Yerkes tested a psychologist who was a skilled chess player and found that in his blindfold play, the subject remembered by using the regular symbols for the squares and did not reproduce the board in visual imagery. Bartlett and others discovered that visual imagery is more detailed and gives the individual greater confidence in his recall, but that it is really less accurate than abstract or verbal\* imagery. Most recent events are likely to be recalled visually, while remote events are recalled through words or kinaesthetic images.

*Imagery May Change with Training but Slowly.* There is a general tendency, according to Galton\*, for individuals to shift from concrete to more abstract imagery as they grow older or deal with general principles. He found that his friends of the Royal Academy had little visual imagery. The fact that imagery of one sense may increase with use is suggested by a musical composer. Early in his career he would hear, in imagination\*, only fragments of his compositions. Later, he could present to himself the detailed effects in the score of an orchestration he was writing, as it would sound when played. Intentional training

of imagery type is usually very slow, but, under the influence of demand and through constant use, change does take place.

### ASSOCIATION\*

*Learning is Through Connections.* The re-arousal of a trace\* or engram\* is by means of bonds\* established at the time it was perceived. The trace itself may be pictured as a change in the tissue of the brain\* induced by a sensation\*. This engram persists as long as a memory\* lasts. The engram of one object has been thought of as connected with the engram of other objects seen at the same time with it or in contact with it, since, when one of the objects is experienced again, there is a tendency for the other object to be recalled without itself being experienced. This principle has been known for a long time as the law of association\*. It is much like the more recently introduced notion of the conditioned\* reflex. The difference is that association applies to images\* and other conscious processes, while conditioning\* is applied to the operation of connecting a reflex\* with a new stimulus\*. Stated objectively, the simplest law of association is that objects or events that occur together or in immediate succession tend later to return together, when the stimulus for either excites a sense\* organ. Probably a connection is made between the parts of the nervous\* system that are the basis of the perception\* of each object, and this connection carries a nervous impulse from the sensory\* area excited by the stimulus to the sensory area originally excited by the other stimulus. When the new area is aroused, the image that is related to it reappears in consciousness\*.

*Modifications of the Association Theory.* Various objections have been made by many schools of thought to the statement of the association\* theory. One school insists that it is the total situation, not the separate objects or elements that is involved in the recall\* or the revival. Another worker, Thorndike\*, states that it is not the mere appearance of the two events together, but the development of some emotion after their appearance that is effective in uniting them. From our present point of view, these differences are minor. Observation, popular as well as scientific, indicates that all recall\* can be referred to the appearance together of the event recalled with some other event or stimulus, the cue\*,

that has been at some time observed in connection with the event. The divergent theories represent exceptions based on unusual cases or philosophical considerations.

*Recall as Dependent upon Strength of Connections.* Experiments and chance observations show that the likelihood of the recall of one item in connection with another item, increases the more frequently the two items are presented together. The chance of recall is also improved if the stimuli causing the two events are increased in strength, or if they receive greater attention, or if they arouse a greater emotional response when they earlier appeared together. The likelihood of recall decreases with the lapse of time following the original experience. The factors that determine the strength of the connection are; frequency and recency of the association and the intensity of the original stimuli. It is impossible to revive a trace\*, or the event that corresponds to a trace, unless some stimulus\* that was experienced at the same time as the formation of the trace presents itself just before the trace is to be re-aroused.

### SELECTION OF ASSOCIATES

Each trace or its corresponding event or object has been connected at different times with numerous other traces. We call the revived event an idea\*. Determination of which idea shall present itself depends not merely upon the strength of connections, but also upon other experiences which the individual has had just before the stimulus leading to the recall presents itself. Thus, if one has been asked in an experiment to name the country in which certain items are found and then is given the word, "Nile," Egypt will be recalled at once. If the general question is, How long is the river? or, In which direction does it flow? the appropriate answer suggests itself, if it is known. This directive effect has been called the task\*. Much the same is the effect of the general set\* at the moment, as a result of the environment or context. If one is in a museum, the sight of a bird will stimulate recall of its class name or of other scientific knowledge. If one is thinking of a vacation, the bird may cause recall of some expedition on which one has seen such a bird. Task, set, and

context are different kinds of anticipatory preparation that select the events to be revived.

## EDUCATION AND SOCIAL PRESSURE DIRECT RECALL

General training prepares the way for the grouping of the sets and purposes that prepare for recall. Many of the forces mentioned as controlling selection of the objects of attention are also effective for determining the course of thought. By means of social pressure, we may be held to one line of thinking or we may be brought back to it. While writing a theme one may find that ideas foreign to the subject of the theme are barred, and, if they present themselves, one turns back to the material appropriate to the theme. Similarly we dwell readily on thoughts of conflict, of love affairs, and similar matters that are connected with or essential to the survival of the race. Selection of ideas follows very much the same rules as does selection of the objects to be seen.

## COLORED HEARING

The processes of recall\* explain most of the mental life of the individual. In addition to the revival of events in approximately the same order as in their original occurrence, there are many cases of deviations from such order. One deviation of a very general nature, which does not appear often, is known as *synaesthesia*\*, or the grouping of qualities from two senses, when the qualities do not seem to have any common connection. A small percentage of the total population has one sensation\* excited by another in an unrelated sense, and, so far as can be known, without previous occurrence of the two experiences together. Thus, one subject reported a sensation of taste when acid was applied to a wound on his chest. More frequent are cases in which one experiences colors when stimulated by sounds. There are individuals who see colors in connection with different letters or words. Scriabin revived colors in connection with chords and melodies. Colors were so vivid for him that he suggested that colors of the tones he saw should be projected on a screen in time with the music.



## NUMBER FORMS

Similar transfers\* are found between digits, calendars, etc., and special diagrams. Galton\* found that many individuals arrange the numbers in patterns. One subject may arrange the digits from 1 to 20 on a vertical line, those from 20 to 100 on a connecting horizontal line, and then repeat in a series of steps as high as he cares to go. The forms are peculiar to each individual and, in some cases, are very complicated. These forms are sometimes used for mnemonic\* purposes, so that the individual recalls the position of the number on the pattern each time he thinks of the number. The patterns are used by some of the individuals who possess them for calculations. A mathematical prodigy may multiply 5 by 10, by thinking of five as half way up his 1-to-10 vertical line, and of 10 as at the top of this line and have these two positions recall the middle of the 10-to-100 horizontal line (that extends from the top of the 1-to-10 vertical line) where 50 is placed. Both the combinations in colored hearing and the number forms persist consistently over much of the life of an individual. Claparède found cases in which they had not changed appreciably in thirty years.

*Theories of Colored Hearing.* Two explanations have been offered for these arbitrary associations of one kind of sensation\* with another. The simplest is in terms of direct early formed bonds\*. C may always be red because, during childhood, it was on a frequently seen red block. Another theory, suggested by Werner among others, is evolutionary. It assumes that the present senses were evolved from a smaller number of primitive senses, and that the tones and colors associated in colored hearing were once aspects of the same more primitive sense. The evidence for this theory is rather indirect.

## IMAGINATION

*Forms of Imagination\*.* Any casual revival of trains of images in the waking state is known as imagination. Day\* dreams come under this term. Imagining differs from remembering in that



the combinations are new and in that little serious purpose controls the course of their appearance. The events imagined are not necessarily referred to a definite time and the constructions need not seem true. Imagining may range from constructions that are like reasoning\* to the purely chance combinations such as those in dreams. Terms are loosely used, and there are no sharp lines of division. One speaks of the constructive imagination of the scientist, which is an element in reasoning. Old notions are combined in new ways when one thinks of how to put charges or particles together in order to construct the atom. When this process is demonstrated it constitutes an achievement of reasoning, but imagination may also consist of such experiences as merely wondering what creatures would develop if a horse should grow wings. Artistic creations of the novelist, the musician, the artist, or the architect lie between the near reasoning and the day dream. The difference lies in the seriousness with which the process and its results are taken and the belief\* that attaches to them. All types of imagination follow much the same laws of origin and development.

## DREAMS

*The Place of Dreams.* Much interest has been shown about dreams, especially in the past generation because of the theories of Freud\* and his use of dreams for the diagnosis\* and cure of mental disturbances. The dream, however, from the earliest times has been an object of human interest. It was believed by primitive man to be an indication of the future, and even when not taken so seriously, it always aroused interest. All investigators agree that the dream is excited by some event of the preceding day that persists into the sleeping period. Some dreams are caused by stimuli that affect the senses during sleep. Experiments on sleep have afforded opportunity for studying the influence of chance noises or intentionally produced noises on the initiation of dreams. Application of ice to the feet may start dreams of arctic exploration. Once started, the dream often takes a bizarre course and frequently produces objects or events that are not consistent with reality, although lines of connection can usually be traced.

*Freud's Theory of Dreams.* Freud\* and his school have given an important place to dreams in the theory of mind. Freud believes that mind is divided into two distinct realms. One realm we are aware of, and this he calls the conscious\*. In addition to the conscious, there is a much larger realm of which we become aware only when we study the irruption of its constituents into consciousness. The latter realm is the unconscious\*. All memories that are not being thought about are in the unconscious. Of these memories, Freud is most impressed by ideas or incidents that are regarded by society as improper, which are suppressed in the individual by what Freud calls the censor\*. Freud assumes that sex experiences and sex imaginings are responsible for most of the minor and some of the major mental disturbances. They produce the disturbances by being repressed\* in the unconscious. They are always struggling to rise to consciousness\* in order to shock the censor and the socially organized individual. The dream is the result of such an appearance of a repressed idea in consciousness. Freud has a superconsciousness\*, the sum of ideals. This superconsciousness or *superego* does not affect the course of dreams.

*Interpretation of Dreams.* Freud's elaboration of the above theory is that the unconscious seeks to force these libidinous ideas upon consciousness and, to introduce them, takes advantage of the fact that the censor\* is relatively off guard during sleep. However, even during sleep the censor is not sufficiently off guard to permit everything to pass, and it is therefore necessary for the true references of the dream to be *disguised*. The disguise consists first in the use of symbols for the more objectionable objects. A second means of disguising the meaning of dreams is that a dream is always much *condensed*. Other authorities had noticed that many incidents might be represented in a very brief period. Freud suggested that we dream in shorthand, and that the condensation frequently modifies the real meaning of the dream. Dream incidents are also distorted. One person is substituted for another, so that a dream that is apparently about one person is really representative of the act or emotion of another. All these

phenomena are means by which the unconscious deceives the conscious. Freud also gives a basis for the dream by asserting that it is often a concealed wish. An individual who cannot bring himself to wish openly for some of his unconventional desires, may conceal them in the dream and then indulge in them at will (wish-fulfillment\*). Freud analyzes the dreams of patients to discover events that are responsible for their illnesses.

*Hallucinations.* A phenomenon, closely related to dreams, that appears occasionally in the normal individual, and very commonly in the abnormal, is hallucination\*. Hallucinations are revived experiences that are so vivid that they are mistaken for sensations\*. Just as in a dream the events have all of the signs of reality, so hallucinations are waking experiences in which an object seems to be actually present when later evidence shows that no such object was involved. In attacks of delirium\* tremens, the patient sees mice walking on the wall at the foot of his bed, and cannot be convinced that they are not real. The sufferer from dementia\* praecox hears voices that are as real to him as the voice of his physician. He obeys them even when they command him to commit murder.

*The Characteristics of Hallucinations.* Hallucinations are mistaken for real sensations apparently in part because of the vividness of the sensory elements themselves. In diseased brains, the sensory\* areas are apparently overactive, and the response to an association\* is as strong as the response to a direct external stimulus\*. Some normal\* individuals recall events so vividly that they seem real. The eidetic\* imagery mentioned above belongs in this class. Hallucinations may be induced by suggestion in hypnosis\*. They also appear at moments of excitement in normal individuals. Many such cases are on record. Hallucinations are more likely to present themselves in abnormal\* individuals, and then they are due in part to the inability to take a critical attitude towards an experience. Just as in sleep the brain is acting at a low level of efficiency and part of the belief in the reality of the dream is due to the lack of alertness of the whole, so in diseased mental conditions the brain responds too complacently to the suggestions offered.

## TEST QUESTIONS

A. *True-False Statements.* Read each statement and decide as to its truth or falsity.

1. Ideas are kept each in its own cell.
2. An engram is related to a change in the constitution of nerve tissue or nervous connections.
3. A memory after-image is in the eye alone.
4. A visual minded person is more inaccurate in recall after a month than is a motor minded person.
5. One never can recall an odor.
6. An individual can recall only objects that are presented to those senses for which he has imagery.
7. An eidetic image is one that could be mistaken for an object.
8. Two impressions that are presented together have no tendency to recall each other.
9. We can recall anything at any time no matter whether the right suggestion for it is present or not.
10. An emotion after the successive appearance of two objects decreases the tendency for one to recall the other.
11. The Gestalt School does not accept recall through association.
12. An association is a conditioned reflex between ideas.
13. A memory image is not to be distinguished from a sensation.
14. Vivid impressions are more likely to be recalled than vague ones.
15. For a few individuals each tone has a different color.
16. Recall in general is weaker the longer the time since the original experience.
17. A factor in recall is the ability to turn away from the frivolous in order to wait for an association that will be in harmony with what we need to write.
18. Day dreams are accepted as true.
19. Dreams foretell the future.
20. Freud asserted that dreams are the expression of unconscious wishes.
21. A dream is the expression of a conscious memory.
22. The real meaning of a dream is concealed by too great condensation.
23. An hallucination is a frequent phenomenon in normal mental life.

B. *Completion Statements.* Read the incomplete statements and decide upon the words that would complete each statement.

1. An impression made by an object on the retina is followed by  
an image, due to on the  
; then by a , due  
on the ; and then by a image  
due to  
on the in the .
2. The sense most frequently used in recall is ; next in  
frequency is ; and last, .
3. The type of imagery varies with and .
4. A trace is re-aroused when one has previously seen an object  
that it in or
5. Strength of association depends upon ,  
, and of the occurrence  
together of objects.
6. What trace shall be selected depends upon  
as well as upon the strength of the connection.
7. Synaesthesia is the term applied to .
8. The events of the dream are recalled .
9. Freud asserted that the dream is always
10. The meaning of the dream, Freud says, is always concealed by  
, or , or

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## CHAPTER TEN

### *Attention*

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#### THE FACTS OF SELECTION

A STRIKING FACT of experience is that appreciation is limited to one aspect or object at a time. You can see now one object and then another, but you cannot see both at the same time unless you fuse them into a single pattern of a larger object. Similarly, you can watch a moving car or you can recall a scene of yesterday's excursion, but you cannot do both at once. Again, in a drawing you can see one series of outlines or another. You can make the black masses prominent, make them the figures\*, and let the white sink back into the ground\*, or you can make the white the prominent aspect, the figure, and then the black masses sink back to constitute the ground, but you can't make both prominent at once. When one aspect is the figure, the object seems to be one thing, when the other aspect is the figure, the object seems to be something else. Rubin, who investigated the phenomenon at length, found that when one aspect was made the figure it would not be recognized as the same object that had been seen when the other aspect was the figure. The transformation of the entire experience was complete with the alternation between white and black as the figure. (See Fig. 25.)

#### ATTENTION AND THE OPPOSITION BETWEEN FIGURE AND GROUND

This selection of one aspect or another is known both as attending and as the opposition of figure and ground. Attention\*

is more general because it can be applied to the selection of one object or aspect of an object indiscriminately. It can be applied to the preference of one sense over another, or of memory over perceived object, as well as to one phase or characteristic of an object. Attention has the advantage of being a word in current use in every day language and also of having a verb, attend, which may be used conveniently. We may enumerate a number of specific facts that may be designated either as figure\* and ground\* or as attention\*.

*The Limits of Perception\**. An important fact is that only a single object can be seen at the same moment. This statement may need qualification or explanation, but certainly only one aspect of an object can be seen at a time. If black in a design is the figure\* or prominent, the white cannot be the figure at the same time. When several small objects are presented simultaneously as many as five can be seen at one time, but possibly these are first fused into a single object and then picked out as parts and counted one by one. If as many as five dots are shown for a fifth of a second or less by means of suitable apparatus, one can see them at a single exposure. Probably this appreciation that there are five dots is due to a series of observations in the memory\* after-image. The image lasts long enough to permit counting to five but not long enough to count more. When objects are groups of dots arranged in threes or fives, almost as many groups can be seen as single dots. Three to four groups of three dots arranged as triangles will be seen, or three or four small words will be seen at a single exposure.

*The Duration of Attending*. The time during which an object or an aspect of an object may be clearly observed is also limited. Probably an aspect of an object can dominate consciousness\* for but a fraction of a second. Then the object shifts slightly, it changes its character, or one's attitude\* towards it changes. Sometimes the shift of attention is to something else, to another object, or to a memory\*, or to wondering whether one is really watching, speculation which is in itself a shift of consciousness. More obvious are longer variations or fluctuations. Earliest observed was the fact that a faint stimulus\* varies in clearness from below the threshold\* to being very obvious. A faint light will be seen to

vanish every three to five seconds and then become clear again. These periodic vanishings can be demonstrated most easily by placing a series of small black squares of equal size upon a white disk, radiating from the center, and then revolving the disk rapidly. The squares produce a series of gray rings decreasing in brightness from the center out. The outermost rings are invisible, the innermost clearly visible. The observer can select one ring in between that will be seen part of the time and will disappear at times. Records of the time that one ring is seen well, show that the fluctuations occur at intervals of from two to five seconds. The periods during which the fluctuations are seen and the periods during which they vanish will vary with the distance from the center and thus with the brightness of the gray ring. If instead of watching a ring of this kind, one makes a record of the periods during which a small dot is actually observed and distinguishes between complete awareness of the dot and wondering whether one is observing it, and if one asks other subjective

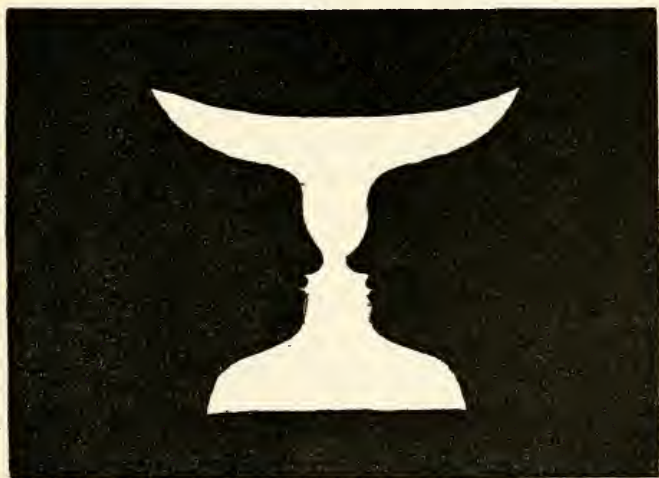


Fig. 25. The Rubin figure to illustrate figure-ground. When the white is the figure it is seen as a vase; when the black is the figure two faces are seen. (Reprinted with permission of the Macmillan Company from Pillsbury, *Fundamentals of Psychology*, 1934, p. 368.)

and objective questions, it will be clear that there are many more fluctuations and that the periods of complete absorption are very much shorter than these fluctuations.

### ALTERNATIONS OF FIGURE AND GROUND

Fluctuations\* between figure and ground in the Rubin figures are usually slightly longer, more like the fluctuations of the rings on the disk. Fluctuations can also be seen in line drawings that can be interpreted in two ways, as in the case of steps, cubes, and many other representations. If a color is shown to one eye and its complement to the other eye by means of a stereoscope, an alternation will occur between one and the other at about the rate of the fluctuations of the disk. The fluctuations all indicate the constant change which goes on in consciousness and the slight possibility of long persistence of any one object or interpretation of an object.

### THEORY OF FLUCTUATIONS

A simple explanation of the fluctuations\* is that they are caused by the fatigue\* of the neurones\* of the cortex\*. The shortest periods correspond roughly to the refractory period of the nerve\*, and the longer periods may correspond to alternations of fatigue and recovery with changes in circulation, although it is not assured that any specific circulatory rhythm corresponds approximately to the wave.

### ADAPTATION OF SENSE\* ORGANS IN ATTENDING

Attending is accompanied by many movements in different muscles of the body, so many that Ribot (1839-1916) suggested that attention might depend in some way upon bodily movements. These motor processes include changes in the sense organs that adapt them to the best reception of the stimuli. Thus in the eye, the ciliary\* muscle contracts as one looks at a near object, and permits the lens to become just rounded enough to give a clear image of the object. The two eyes converge\* so that the image of the object seen falls on the fovea\* of each eye and thus gives a single clear image of the object. The head is turned to



bring the more sensitive ear toward the sounding object, if the ears differ from each other in acuity. Sniffing increases the sensing of smoke, and rubbing the tongue against the roof of the mouth brings the substance to be tasted more closely in contact with the sense organs on the tongue. These and other adaptations of the sense organs occur.

### GENERAL BODY MOVEMENTS IN ATTENDING

Other movements take place in most of the members of the body. The hands imitate any movement attentively observed; the body as a whole sways toward the runner on the football field. More generally, the brow wrinkles, the fist is clenched, and the muscles all tighten as one concentrates on a mental task or watches closely an object under the microscope. The breath is also held, the heart beats faster, the blood vessels in the outer skin contract so that the feet become cold as one works hard in a coolish room. All these are accompaniments of the attending process. Some, like the adjustments of the sense organs, or holding of the breath, which stops the noise of breathing, or tensing of the muscles of legs and trunk that keeps the body rigid have a definitely beneficial effect upon the reception of the stimulus\*. The changes in circulation increase the efficiency of the body as a whole. The other movements may be connected by chance with the total mass.

*Movements Follow Attending.* While the movements certainly render perception\* more effective, they seem to follow upon attending rather than to precede it. Something suggests the importance of appreciating an object clearly and arouses the pattern of contractions that aid complete perception of the object. Attention processes, with all of the motor accompaniments, are reactions to a stimulus on the basis of the needs of the individual organism. So far as the two do not occur together, the mental phase seems to precede the motor responses.

*The Conditions of Attending.* The selection of the object that shall be attended to depends upon the immediate stimuli in the environment and upon many factors in both the immediate and remote past experience of the individual. The factors in the environment are mainly characteristics of the immediate stimulus\*

or of the object observed, although surrounding objects may facilitate the process of observation. An intense stimulus will be noticed when a faint one will not. Within limits, the large object will be appreciated while the small one passes unattended. An exception is with objects so large that they constitute the background as a whole and are not seen because they are taken for granted. For very short intervals the greater the duration of a stimulus the more likely it is to be noticed. Again, the advantage of increased duration is quickly lost because of the greater advantage of change. A changing stimulus, a flickering light, an object in motion, even the cessation of a stimulus, as when the ticking of a clock stops, will make the earlier activity apparent.

*Subjective Factors in Attending.* Certain forces in the individual himself or in his experience are determinants of what shall be noticed. Among these forces are the stimuli just preceding, or the objects that are recalled just before the moment of observation. If you desire to demonstrate the presence of an overtone in a note and will sound a note of the same pitch as the overtone just before listening for the overtone, you will readily hear the overtone itself. Recalling a note of the appropriate pitch will have the same effect. Picture to yourself the type of cell you want to see under the microscope and you will see it. If you search without an image of what you want to see, you may fail to observe it. The aim in attending may be more general. If you look at a watch to see the time, you will appreciate what time it is. Should you look to see whether the dial is of metal or porcelain, you will have the answer to that question but will be unable to tell what time it is if you are asked a moment later. This effect has been called the effect of task\* or purpose. The task or purpose is itself suggested by some one else or by some event in the environment.

## EDUCATION AS A DETERMINANT OF ATTENDING

More remote influences controlling what shall be noticed are found in earlier experiences and education. The events of the near and distant past sensitize the individual to the reception of objects similar to those in past experience. Training in a game makes one susceptible to noting the implements of the sport.

Knowledge of books or of machines makes one prone to catch the titles of books in a library or the characteristics of machines in a shop or of instruments in the laboratory. Education of a special kind facilitates observation of related objects and conditions. The musician appreciates music and its instruments; the physician is sensitive to symptoms of disease, the naturalist to the phenomena of his specialty, and so on.

*Evolutionary Forces in Attending.* From a still more remote past come certain inherited tendencies that are present in all men and in many animals. Attraction by moving objects is general among all other animals as well as men. Man is interested in conflicts of all sorts, from a game to war, from the controversies of political parties to the rivalry between scientific theories. Love affairs and all matters related to sex are of universal appeal. The appearance of the new or strange is also certain to be noticed. All these tendencies are to be referred to the requirements for survival. Anything that moves must be noticed lest it be a source of destruction. Animals that fail to observe perish, and the tendency to observe goes on with the survivors. Those uninterested in mating and in love affairs fail to propagate and so are not represented among succeeding generations. For primitive individuals, conflicts also necessitated participation or escape. Even curiosity and the induced investigations of strange events were conditions of survival. These most fundamental tendencies to observe are to be regarded as persisting in modern man because his forebears had to have them to live. The tendencies are basic enough to account for the appeal of novels and of moving pictures, which must hold the popular fancy if they are to be successful.

*Social Pressure in the Control of Attending.* Basic to the tendency to adjust behavior to the demands of society, even in opposition to native tendencies and temporary purposes, is another tendency related to social pressure. Individuals show an inclination to attend to what is expected of them by the group of which they are a part. They attend to what is being said in a classroom or in church because they are expected to. One subordinates temporary pleasure to remote ends that are approved by the group of which one is a part. Studying in order that one may

attain high rank in school, or, even without such purpose, mere physical attendance at school, with its uncongenial as well as congenial tasks, is a form of response to the social opinion that approves the professional career. The social pressures develop habits\* and purposes that direct the attention\* of the child and of the adult.

*Perceiving Determined by Earlier Experience.* On the whole, one can explain the selection of what is to be perceived as due to native\* tendencies which are fixed and adjusted by training and habit. One has native tendencies that lead to the accumulation of certain experiences. These first acquisitions aid in the perception of similar experiences that are subsequently presented. The later acquisitions spread to include wider groupings of experience that constitute attitudes\* and purposes. All such acquisitions are controlled by the demands of the social group. What seems to be a spontaneous reaction of the individual towards one object or stimulus rather than another proves on close examination to be the product of a few inherited tendencies acted upon and modified by a lifetime of experiences.

*The Types of Attention.* The kinds of attending popularly recognized can be referred to the various conditions that control attention. For some reason, our everyday vocabulary refers to the forms of attending to the will\*, a term that modern psychology does not make so much of as does the popular view. If the student attends to something that is forced upon him by strength of stimulus, his is involuntary\* attention (attention against the will). Attention to an activity that is favored by his training, his inheritance and the purpose or attitude of the moment is non-voluntary\* attention. Attention, under the influence of social pressure, that ordinarily seeks a remote end is called voluntary\* attention. This division into types of attention is emphasized by the fact that each type is accompanied by a different feeling. Involuntary attention may be marked by a feeling of surprise or of resistance to disturbance. Non-voluntary attention is accompanied by a pleasant feeling that we call interest. Voluntary attention usually comes after a conflict with non-voluntary attention, a conflict which evokes widespread muscular contractions



that give rise to the feeling of strain called effort\*. Although both interest\* and effort are the effects of the particular conditions of attending, we always assume that the acts of attention are the effects, while in point of time we are interested because we attend. Similarly, we think that effort causes us to attend, whereas the more likely statement is that the conflict between inherited desire and social demands gives rise to the diffuse motor contractions that we call effort.

### DOES DISTRACTION DECREASE EFFICIENCY?

*Distraction.* A factor affecting attending that has been much studied experimentally is the effect of distraction\* upon the efficiency of work. One would assume that any disturbing stimulus would reduce ability to keep any other task or stimulus in the center of the field or to do efficiently whatever is to be done. In fact, a distinguished investigator, in the early period of research, requested a student to investigate how distracting a stimulus must be to prevent entirely the performance of a task. The authority who set the problem believed that if a subject is comparing weights, it should be possible to apply a distraction great enough to reduce the accuracy of the comparisons to zero. When the accuracy of judgment reached zero, one would have just compensated for the effect of attending, and that amount of distraction could be regarded as equalling the force of attending.

As a matter of fact, when the investigation was completed, the investigator was surprised to find that the distraction increased the efficiency of the worker rather than decreasing it as was expected. There is reason to believe that distraction\* may arouse the worker to greater effort\* in order to overcome it, and such effort is more than sufficient for the purpose so that more is accomplished than without distraction. The evidence that increased effort is exerted in these cases was set forth by Morgan and Ford. Both found when they recorded the pressure exerted in writing under conditions of distraction, that subjects pressed considerably harder when distracted than they did when no distraction was present. Also, the rates of pulse and breathing are higher under distraction, and even the metabolic\* index is in-



creased, as measured by the amount of oxygen taken in and the amount of carbon dioxide given off. Although one accomplishes more when a distraction is present, the added accomplishment is achieved at the expense of greater effort\* and more fatigue\*.

*Summary.* The fact of selection is highly important in all mental life. Attention is constantly shifting from one object to another as one views a landscape or an audience, or as one turns from observation of objects to memories of older experiences with the objects. To appreciate that these shifts are not by chance, but that each has a specific cause or causes which may sometimes be discovered, is important for understanding many aspects of activity.

### TEST QUESTIONS

A. *True-False Statements.* Read each statement and decide as to its truth or falsity.

1. Attention is a name for differences in clearness or dominance of a sensation.
2. A change from figure to ground has no relation to attention.
3. One can attend to an indefinite number of objects at the same time.
4. One can attend an hour without a shift of attention.
5. When two stimuli, one appealing to the eye and the other to the ear, are applied simultaneously, the stimulus attended to appears to follow the other stimulus in time.
6. The movements of the eyes are due to shifts in attending or to the internal factors that produce attending.
7. As one attends to a movement, one makes a similar movement.
8. One can determine whether or not an individual is attending by feeling his pulse.
9. Long continued difficult attending is accompanied by strain in the muscles.
10. One can attend better to small objects than to large.
11. The thought of one moment determines the attending to the next.
12. We attend to objects that are not essential to our survival.
13. Attending in spite of difficulties is accompanied by interest.
14. The strain we call effort is the real cause of attending.

15. Social pressure is a phrase to designate the influence of desire for approval in keeping our attention upon a lesson when we would prefer to be playing.
16. It can be said that interest in a love story is the product of evolutionary factors.
17. Distraction decreases capacity to accomplish a task.
18. Attention can be measured by determining the amount of distraction that will reduce accomplishment to zero.
19. One can turn from sensory experiences to memories because of a change in "set," as well as from one sensation to another.
20. Attention is a general name for all the forces that determine the selection of a stimulus, together with the physiological changes that result from or determine the selection.

B. *Completion Statements.* Read the incomplete statements and decide upon the words that would complete each statement.

1. One may see as many as                      dots, when they are exposed for 1/5 second.
2. One can observe a faint light for about                      seconds, without its seeming to disappear.
3. As one looks from a distant to a near object, the movements of                      ,                      and                      can be noticed in the eyes.
4. Attending                      movement (precedes or succeeds, causes or is caused by).
5. The pulse                      during attending, and the volume of the hand                      .
6. Stimuli that are attended to are                      , are and are                      .
7. Two of the important subjective conditions of attending are and                      .
8. Distraction renders attending                      , for it                      .
9. Interest is the                      of attending.
10. Voluntary attending is due to                      , and its conscious accompaniment is                      .

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## CHAPTER ELEVEN

### *Perception*

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#### **DEFINITION OF PERCEPTION: PERCEPTION IS THE AWARENESS OF THINGS AS ORGANIZED UNITS**

PERCEPTION IS THE ACTIVITY of sensing, interpreting, and appreciating objects. Perception is more than a sensation\*, for it involves interpreting the material that is received from the senses. A percept is always organized. It is always unified. Most authorities find that a percept contains elements, from earlier experiences, that have been retained and are again aroused by the stimulus\* so that the subject can interpret the present experience. The total effect in perception is the reception of a unit. This means that the smallest unit of concrete experience is the percept. It corresponds to the *object* of the non-scientific individual. As a result of the reception of a stimulus by the sense\* organ of a cultivated human being, a unified object comes to consciousness\*.

#### **BRIGHTNESS CONSTANCY: THE PRINCIPLE OF CONSTANCY\***

That there is a unity of the object in perception is indicated by the phenomenon known as constancy\*. In brief this means that although conditions may change so that the stimulus\* varies markedly, an object maintains its standard brightness\*, color, size, and form. A sheet of white paper is several hundred times as bright in sunlight as in moonlight. Nevertheless, if it is recognized as a sheet of white paper, it always is accepted as white, no matter how much the actual physical illumination may vary. The paper seen in a shadow is still white, and the shadow does

not seem to affect its brightness or affects it very slightly. If the paper is in a shadow and is viewed through a small hole in a screen placed between the observer and the paper, the brightness is seen at its physical value. When one can see that a shadow is cast, the brightness retains its standard value.

*Color and Size Constancy.* The same statement can be made of color. A bit of gray or colored paper in a blue light seems of its real color, if you know what the real color is, just as the brightness\* is the true brightness. Similarly, an object is always seen at a distance as of a standard size, no matter at what distance it is. We know that the image\* cast on the retina\* becomes progressively smaller as the object is farther from the eye, but that the actual size of the object seems the same in perception\*. The size accepted is, for an object that can be handled, the size that it would have at convenient reaching distance. For larger objects, the standard distance accepted as determining size is somewhat greater, is referred to a distance that will give a view of the whole at a single glance. Form, too, is kept constant. Changes caused by perspective and the distortion caused by oblique positions in the field of vision are neglected in the interpretation. The object takes the form it would have were it perpendicular to the line of sight.

The image of an object also shows no distortion as a result of falling upon the spherical surface of the retina. What is seen is always seen as if the retina were a plane surface. A percept is always a unit. A percept is a stable unit that is not changed by illumination, by distance, or by changes in the orientation of the object. It is experience of an object as if under standard and most favorable conditions. No unfavorable circumstances of the external environment are permitted to influence the appreciation of the object. The observer interprets objects automatically as if they were being seen under the best possible conditions.

### **THEORIES OF PERCEPTUAL CONSTANCY: PERCEPTS AS IMMEDIATE WHOLE AND AS THE RESULT OF CONSTRUCTION**

Two explanations of this phenomenon of constancy\*, as it is called, have been suggested. One assumes that the observer knows what the separate results of stimulation of the sense\* organ are and then corrects them by reference to the way the objects would



look under the most favorable conditions of seeing. The other assumes that the experiences are immediately given in the true form with no knowledge of the fact that it might be seen in any other way. The former explanation develops into a theory of how the object seen may be corrected under the influence of earlier experience. The second explanation is content to accept the immediate fact of correction and to determine the limits within which interpretation is correct and the circumstances that will permit the object to be seen as physiological sensitivities show it to be. The former view regards what we assume to be the elements to be the real existence. The second view assumes that the object as we experience it is the datum and pays little or no attention to the elements that may be regarded as composing it or which are presumed to constitute the basis of the experience. The former view makes more assumptions and takes its assumptions as the reality. The latter view assumes the final interpretation as the real thing and makes little attempt to trace its origin. Both are willing to grant the same final facts. The difference between them is in the assumptions as to what lies behind the facts.

*The Assumptions of the Constancy\* Theories\**. Probably the second of the above theories is correct insofar as the individual is not aware of any of the simple experiences that are assumed to be involved in the interpretation of perceptions. When looking at a sheet of paper that slants away from the eyes, one does not first see the lines of the sides converging towards the vanishing point and then see them parallel and at right angles towards the top and bottom. One sees the lines from the first as parallel lines. And so with all the other instances of so-called constancy. The only justification for a theory that would assume the sensations\* to participate would be the argument that one first sees the lines in their distorted forms, then learns that they are not distorted, and, finally, sees them as one has learned them to be. This theory may seem plausible, but it does not rest upon specific fact or observation.

### READING AS PERCEPTION

The process of perception\* or interpretation can be illustrated very well by reference to the simple process of reading. Reading

is more obviously than other skills a process of interpreting because we not only see the letters and words but interpret them to be things quite foreign to the simple physical stimuli. In discussing the processes of mere reception of the letters it may be said that the eye takes in only a small part of a line in a single act. The division of the line is made by pauses. When the eye is in motion, the retina\* can perceive only blurs. To avoid the blur effect the eye stops at intervals along the line so that all reading occurs during these pauses known as reading pauses. Photographs taken of the eye during the process of reading show that the pauses are from 0.2 to 1.0 second in length, and that if the reader is a skilled adult, there are from two to six pauses in a line of ordinary length. Children and readers who lack training may have many more pauses. One can see the pauses if one watches attentively the eye of any individual as he reads.

Words rather than letters constitute the material that is read. In some cases, sentences or phrases may be read as wholes. Usually two words or parts of two words will be within the range covered during a single pause. Various experiments indicate that what is seen at a single exposure is a unit or pattern. When several dots or points are combined in a pattern, the whole pattern is seen as readily as a single dot. Words form such patterns, and for experienced readers phrases or short sentences constitute the unit. Many children have been taught to see only words and to be inattentive to the letters. This method of instruction is an outgrowth of the evidence from psychology that words are read as wholes. The words are recognized from the total pattern formed by the arrangement of high and low letters, with a relatively small contribution from the letters as letters. We easily overlook misprints, such as the substitution of one letter for another or the omission or addition of letters, so long as the pattern or form of the whole word is not too great a distortion of the general form.

*Reading Words Influenced by Context.* As in many other cases of perception, what is seen depends upon the attitude\* of the reader or the context of the word. An individual who comes to an experiment in reading after having read a French book will tend to see French combinations. If the words contain many misprints, interpretation of them may be changed by calling out

a word before the subject is asked to look at it. Call out a word and the distorted printed word will be seen as one word; call out another word and the same printed word reported will be different. The interpretation depends upon the setting or attitude as well as upon the images that are actually seen. The process of completing the letters seen makes it difficult to detect errors in proof reading. One overlooks the misprints because the true letters are supplied from old knowledge under the influence of context and what is expected by the reader.

*Reading Translates Words into Images.* In reading, too, one translates from the mere words into ideas\* or objects. As one reads, the pictures that were imagined by the author are suggested to the reader. One may be little conscious of the words, but appreciate merely the ideas or objects. This is true only when one is reading simple material and has had much practice in reading. In the beginning, a child will translate the words seen into the sounds he would hear if he spoke the words, or into movements used in his speech or in his memory of the way the words felt when he spoke them. This habit\* may persist in the student at college, and thus make reading a very slow process. Success in studying usually requires that such a habit be changed. This result can be attained by compelling one's self to read more rapidly than one can speak. Gradually one will learn to short circuit the process and to pass at once to the images or ideas without using the words of inner\* speech.

*Eye-Movements Must Be Effective.* One can also learn to adjust eye-movements to the best advantage. These adjustments are made automatically when the student is urged to read more rapidly. The eyes of a subject can also be photographed while he reads, to disclose bad habits of eye movement. More definite methods of correction can then be applied. As a rule such measures include efforts to reduce the number of pauses per line and to avoid regressive\* movements along the line. Attempts to read rapidly cause these changes to take place spontaneously, but conscious intention may hasten the process.

*Reading Illustrates the Interpretation Theory of Perception.* Reading falls readily into the classical theory of the perception process. The percept is induced by a stimulus\*. The stimulus

revives old traces as well as immediate sensations\*. The arousal is dependent upon prompt association\* made under the influence of the context and attitude at the moment, so that what we call an object is experienced. The interrelations with old experiences give meaning, and the interpretations correct all or most of the sense distortions.

## THE GESTALT INTERPRETATION OF PERCEPTION

As opposed to this explanation, the Gestalt\* or configurational school asserts that stimuli tend to group themselves by virtue of certain purely empirical laws. Most frequently mentioned of these are

(1) *Proximity*. Lines or figures close together are more likely to be grouped in a single figure than are more distant ones.

(2) *Similarity*. Stimuli such as dots that are alike can be grouped more readily than dissimilar ones, such as dots and lines, or dots and letters.

(3) *Continuity*. Dots that can be combined to make a line or more complicated figure are observed as a unitary form.

(4) *Closure*\*. All figures tend to have continuous contours, —to be perfect in every sense. A gap in a circle is overlooked when seen in a faint light or for a very short time. The law of closure is applied very widely to interpretations in thought as well as to figures. Logical gaps are closed as well as perceptual, and in percepts inconsistencies of all kinds are eliminated.

(5) *The whole determines the parts*. If an interpretation has been given a complicated group of dots or lines, lesser meanings will take their meaning from the interpretation of the whole.

As opposed to the analyses and interpretations of the older theories of perception, the Gestalt School enumerates merely observed laws of seeing an object and makes no attempt to analyze the experience into units or to relate it to earlier experiences.

## SPACE PERCEPTION: APPRECIATION OF POSITION ON SKIN AND EYE

In discussing perception it is usual to consider certain aspects of experience separately, and then to unite these aspects under



common heads for interpretation. Among the most important of these aspects are the space\* relations. Space includes notions of the position of the object as a whole with reference to the person. For objects not in contact with the body, position is determined by distance from the body and by direction. Observing the area within the object itself, we can consider size, contour, and separation of the elements of the object. Space perception is restricted mainly to sight, touch, and hearing. Touch affords the least comprehensive spatial discrimination, and is restricted to an appreciation of position, supplemented by vague notions of size and of the directions of lines. We have acquired some knowledge of our accuracy of positions. If one touches a man on the hand and asks him to indicate the point touched, he will make mistakes which vary with the part of the skin that has been touched. The usual measure of the accuracy of the perception of position is to apply the points of a compass and ask the observer to say when he can feel two points rather than one. The distance varies from a millimeter or less on the finger tip to forty to sixty millimeters on the back. The more the part of the body moves and the more it is used in measuring distances, the less the distance which must separate the two points. On the arm this distance is longest at the shoulder and shortest on the finger tips.

*Theories of the Perception of Position.* There has been much discussion as to how one knows the position of points on the body that have been touched. About all that has been discovered is that perception of position is aided by certain factors. A picture of the point touched is frequently noticed in localization. One sees the part when a point is being touched. There are also reflex movements towards the point. These movements appear early in life and may be assumed to be caused by inherited connections. Lotze contributed a vague suggestion that there is a peculiar quality in the touch from each point of the skin, which quality he called the *local\* sign*, that immediately indicates the position of the point. A similar problem arises in the case of the eye, where in the fovea\* one can appreciate two points as two when they are from four to six thousandths of a millimeter apart, or when the lines that transmit the images make an angle of one



angular minute. The least noticeable distance between points increases rapidly with departure from the fovea.

## PERCEPTION OF DISTANCE WITH ONE EYE AND WITH TWO

*Monocular Perception of Depth.* One of the most important problems in connection with space\* has to do with the means of appreciating the distance of objects from the eye. Distance is perceived as if it were a line turned towards the eye and therefore does not register on the retina\* directly. One must look for indications of distance in sensations that change as the object becomes more remote. Changes in the eye itself are threefold: change in the muscle of accommodation\*; change in the adjustment of the internal rectus muscles to converge\* the eyes so that the object shall fall on the fovea in each; and the double images that are seen of all objects except the one directly converged upon. The eye is focussed\* for different distances by changing the curvature of the lens to be flatter for distant objects and more nearly spherical for near objects. The lens is naturally shaped to give an image\* of near objects. It is held relatively flat by ligaments that stretch across the eyeball from the side of the ciliary\* muscle. When one attends to a near object an impulse to the ciliary muscle causes it to contract and release the tension that holds the lens flat. It tends to take its natural more rounded shape and so gives a clear image\* of the nearer object. Experiments show that most estimates of distance with one eye are relative. The object that is focussed upon is seen clearly, all else is seen in blurred images. One is certain that the clear and the blurred images are not at the same distance from us, but other means must be used to tell how far away the fixated object seen in a clear image is, and which groups of blurred objects are nearer and which are farther away than the clear image. Some individuals are found to use the degree of strain in the ciliary muscle as an indication of the distance of the clearly seen object from the observer. Others use the signs mentioned below.

*Binocular Perception of Depth.* One perceives distance much more accurately with two eyes than with one. Strain from the internal recti muscles of the eye, the muscles on the side of each

eye towards the nose, increases as the object comes nearer, and the amount of this strain gives an indication of the distance of the object from the eyes. When looking at a distant object the axes of the eyes are nearly parallel and the internal rectus muscles of the eyes are relaxed, when the object is near the eyes converge\* and the strain increases.

*Double Images in the Perception of Depth.* We have two eyes, each of which sends its own image of all objects to the cortex\*. Partly because nerves\* from similarly placed points on the retina\* connect with a single neurone\* in the visual cortex, partly from a habit\* of using the eyes together, we see objects singly under most conditions. If the same object sends its image to points which are not similarly placed on the two retinas, what we call corresponding\* points, we see two objects. The two foveas\* always correspond and so give a single image. Other points equally distant from the foveas and in the same direction also correspond. The use of double images in the perception of distance is possible, since each object that is converged upon sends its images to the two foveas and so is seen as single. All points that are nearer or farther away than the point converged upon are seen as double. Ordinarily, we do not notice the double images, but we none the less use them as a means of judging distance. We can see them if we hold the finger in line with a curtain string and fix our attention on the string. The finger will be seen as two. If we look at the finger, we see the curtain string double. Apparently we tell which of the two objects is farther and which nearer by determining which pair of the double images is crossed. Experimentally, we can determine which image is crossed by closing one eye. If the nearer object is seen in double images, the image on the same side as the eye that is closed will continue to be seen; but if the more distant object is seen in double images, the image on the side opposite the eye closed will continue to be seen, while the image on the same side vanishes.

*The Stereoscope\*.* The fact that doubling of the images is the real basis for the perception of distance is demonstrated by use of artificial double images in the stereoscope. These artificially produced images give an illusion\* of distance where there is no distance. In the simple stereoscope, two photographs of a scene

are taken from slightly different positions. The prisms in the stereoscope cause these images to fall one upon the right eye, the other upon the left, and give the same kinds of double images that would be received if the observer were standing where the pictures are taken. The objects are seen at their true distances. If the pictures are reversed in the stereoscope, the nearer objects will seem farther, and the more remote objects will seem nearer.

*Psychological Factors in Depth Perception.* The means of perceiving depth given above are dependent upon changes occurring in the eye. Other means of perceiving depth are characteristics of the images themselves, and such means may be reproduced by the artist. Most important and most used of the latter is perspective, which makes use of the fact that more remote objects seem smaller because they make a smaller image upon the retina\*. Another means is based on the principle that the more remote objects stand higher in the field of vision. Again, the more distant objects are less clear. If very distant, the intervening air obscures them. Where the air is less dense, as in high mountainous country, distant objects seem much clearer than do objects of the same distance at sea level (aerial perspective). When one looks through a window, movement of the head produces a greater apparent displacement, in relation to the side of the window, for more remote objects than for nearer ones. Different distances of parts of the same object are largely discriminated by means of shadows. If one is looking at the inside of a cup, one appreciates the hollow shape because there is a shadow on the side towards the light. If there is a protuberance on an object it is appreciated as higher than the rest of the object because there is a shadow on the side away from the light and a bright surface on the side toward the light. Naturally, all these phases of an object are interpreted immediately; one seldom is aware of the cues\* for distance until one is told of them or until one attempts to draw.

## APPRECIATION OF THE DIRECTION OF SOUNDS

Perception\* of the direction of sound involves also an immediate interpretation of cues\* that are seldom noticed and can be demonstrated only by experiment\*. Just as perception of the distance of objects depends in considerable degree upon the posses-

sion of two eyes, perception of the direction of sound implies the possession of two ears. A man deaf in one ear is almost totally at a loss to tell the direction of a pure tone\* and is less accurate in perceiving the direction of a noise than is a man with normal hearing. Experiments show that direction of a tone depends upon the fact that the tone reaches the ear which is on the same side as the sounding body a fraction of a second before it reaches the other ear. The difference in time between the stimulation of one ear and of the other is greater the farther to one side the tone is. Also the ear on the same side as the tone receives a more intense sensation than the other ear, and this factor contributes to the discrimination of direction. If one pure tone is directly in front of the subject\*, the other directly behind him, it is difficult for him to say which tone is sounding. Noises apparently change their quality with change in direction, an effect that has been ascribed to the emphasis through resonance of different overtones by the smaller concavities of the external ear.

### ILLUSIONS AS MISTAKES IN PERCEIVING

*Optical Illusions\**. An important feature of perception is the tendency to misinterpret external stimuli to make them seem to be what they are not. We have mentioned the tendency to overlook misprints in reading. A great many illusions have been studied in connection with the length and direction of lines. All such illusions are explained as due to a misapplication of habits\* or to a wrong emphasis upon cues\*. Various explanations have been given for most of the illusions, but all follow the same principles. One of the most striking is the Müller-Lyer\* illusion. Here, if two lines are drawn of equal length but with slanting lines at their ends, in one case turned in and in the other turned out, the line with the end lines turned in will seem markedly shorter than the one with the end lines turned out. The most probable explanation is that the spaces between the oblique lines are confused with the lines themselves. This error of interpretation increases the apparent length of one and decreases the apparent length of the other. (Fig. 26.)

*Illusions Due to Perspective*. Other illusions of length involve a tendency to overestimate a vertical line as compared with a



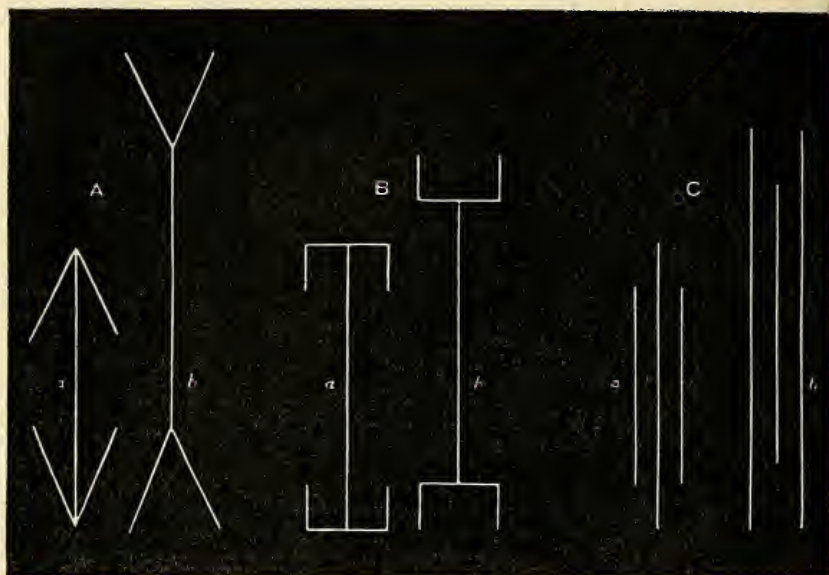


Fig. 26. The Müller-Lyer illusion with modifications. (After Titchener. Reprinted with permission of the Macmillan Company from Pillsbury, *Fundamentals of Psychology*, 1934, p. 446.)

horizontal one, and a tendency to judge broken lines to be longer than continuous ones. Many illusions\* of direction are well known. One group can be classified under the head of over-estimation of small angles and underestimation of large ones. If a straight line is drawn diagonally across a wide horizontal bar, it will seem that the two ends of the line are not continuous. Each end tends to bend away from the side bar. Poggendorff's\* illusion is the name assigned to this illusion. (Fig. 27) Also, a series of parallel lines with short oblique lines drawn across them seem not to be parallel. This illusion is called the Zöllner\* illusion after the scientist who first reported it. Illusions in this group have been explained as due to misplacement of the usual perspective interpretation. Where straight lines cross at acute or oblique angles in nature, they are usually parts of rectangular figures. To interpret them as such, we tend to exaggerate the small angles and to underestimate the large angles.



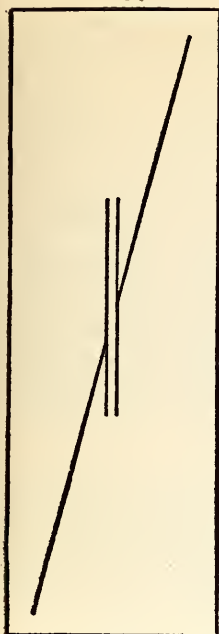


Fig. 27. Poggendorff's illusion. (From Titchener, *Experimental Psychology*. Reprinted with permission of the Macmillan Company from Pillsbury, *Fundamentals of Psychology*, 1934, p. 452.)

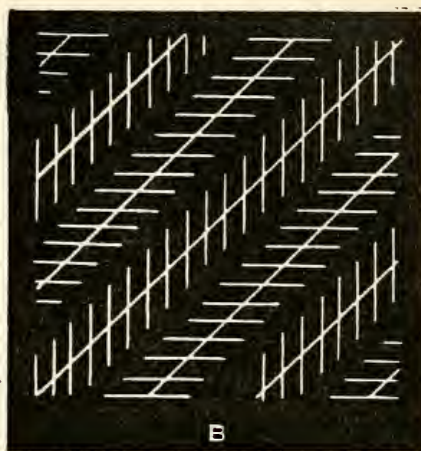


Fig. 28. The Zöllner illusion. (From Titchener, *Experimental Psychology*. Reprinted with permission of the Macmillan Company from Pillsbury, *Fundamentals of Psychology*, 1934, p. 450.)

An illusion which is directly dependent upon the surroundings is the Revesz\* illusion, in which two identical figures with converging sides are placed one above the other. The upper figure seems much smaller than the lower because one expects the convergence of the lower sides to be continued in the upper figure, and since the upper figure is smaller than one expects, it is regarded as actually shorter. If two equal circles have a second circle drawn inside the one and outside the other, the one with the circle drawn inside will seem larger than the one with the circle drawn outside. The observer compares the average width

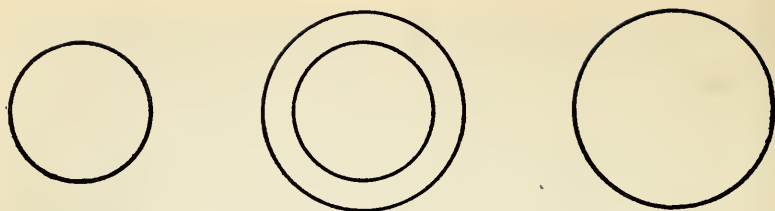


Fig. 29. Illusion due to confluence. The inner circle of the central pair is of the same size as the one to the left; the outer circle equals the one to the right. Together, each approximates the size of the other. (Reprinted with permission of the Macmillan Company from Pillsbury, *Fundamentals of Psychology*, 1934, p. 449.)

of the rings, and this reduces the one circle and enlarges the other. All interpretations of illusions agree in assuming that the observer is misled by confusing minor aspects of the figures with the major aspects that are to be judged.

### APPRECIATION OF THE PASSAGE OF TIME

*Perception of Time.* Closely related in theory to the perception of space is the perception of time. Time is not an entity in itself, but it is an important aspect of all our experiences. Without mechanical aids we can be aware only of differences in duration. We have no natural psychological units for measuring time. When Galileo was measuring the law of the pendulum, he used his pulse beat as a measure of the time of oscillation. Once he had established the law of the pendulum, its oscillation became the measure of time. Experimental results give some indications of the cues\* that we use in estimating time. It has been found that short periods of time are estimated by methods different from those used to estimate long periods. The main evidence for this conclusion is the fact that time spans less than three-fourths of a second are rather uniformly overestimated, so that the first unit seems longer than the second. In the case of longer intervals of time, the first unit seems shorter than the

second, and the duration is underestimated. Our estimates of short periods of time have been said to be based upon the element of rhythm\*.

*Theories of Time.* The time intervals between a second or less and about three seconds seem to be felt in terms of strains from contracting many muscles in the body. Comparing periods of time that are longer than two or three seconds is uncomfortable because the strains become severe. The muscles begin to contract at the first signal and their contractions increase until the final signal. Comparison of intervals seems to be in terms of the intensity of the strains reached at the end of the two intervals. Longer periods of time are estimated by means of the events that take place during them. A busy hour seems long as we look back upon it, if the events that occur are new to us, whereas the hour probably seemed short to us as we lived it through. Experiences succeed each other so rapidly that there is no single period of much strain. The time of waiting for a delayed train seems long because the strains of expectation fill the interval.

## RHYTHM

Closely related to time is the experience of rhythm\*. Rhythm has two aspects. First, it implies the combining of repetitions of the same stimulus\* into groups or units. Eight or more stimuli may be brought into a single unit. Second, in each of the units, certain elements are accented at the expense of the others. The uniting or accenting may be either objective or subjective. When rhythm is objective, the units are separated by wider intervals than the single stimuli. The accent is given by increasing the intensity of one stimulus, by increasing its length, or by increasing the interval that divides it from the preceding or following stimulus. So far as the observer is aware, the rhythms produced in these different ways are identical. One organist played for years before it occurred to him that the accent was produced by holding the key a little longer, whereas to obtain accents on the piano, the note was struck harder.

*Theories of Rhythm.* When sounds come at the same interval and are of the same intensity, one may introduce a rhythm subjectively that is not readily distinguished from objective rhythm.

Two theories have been given to explain subjective rhythm. One theory is that recurrent emphasis is given by attending. The other theory, which would explain objective rhythm as well, is that slight responses of the muscles are made in time to all rhythm, and that the rhythm of sensations from the muscles is basic. Primitive races celebrated the completion of activities, such as harvesting, hunting, etc., by dances that imitated the movements of the tasks. So that the performers might keep time in the dance, music was introduced. Rhythm was extended from the activities of daily life to the dance and from the dance to music. According to this assumption, all rhythm is a feeling of slight movements that spontaneously accompany the hearing of continuous series of sounds.

### MOVEMENT AND ILLUSIONS OF MOVEMENT

Movement is another aspect of experience that needs explanation. As an object moves across the field of vision, it leaves a streak of after-images\* that gives an indication of the direction and length of the movement. One theory holds that these after-images of a moving object offer the basis for an interpretation of the object as moving. Another theory, the Gestalt\*, assumes that movement is an immediate interpretation of the successive stimulation of points on the retina\*. Decision between the two theories is still in dispute. Important evidence as to the nature of real movement has been drawn from experiments of the way movements may be simulated in the moving pictures. Moving pictures project on the screen photographs of different phases of a movement, and the observer reads movement into the pictures. Experiments conducted with single lines give the limits within which movement will be ascribed to lines exposed successively at different intervals and different distances apart.

*Korte's Laws.* A German experimenter, Korte, measured the relations between intervals of time and space that will give the best movement. It is found that when two lines are five degrees apart, and are exposed at intervals between .06 and .09 seconds, one line will seem to move over to the other. If the exposures are .15 seconds apart, the lines seem to be seen successively. If they are but .02 of a second apart the two lines seem to be exposed

simultaneously. Korte's Laws assert that within limits if one increases the distance between the lines one must decrease the time, although not in the same proportion. Differences in the absolute and relative intensity of the two lines also affect the relation between the space and time required for the best movement.

*The Phi Phenomenon.* The movement suggested by these successive exposures of lines at suitable distances cannot be distinguished from the real movement of a line. The phenomenon is much the same in the two cases. When a line moves across the retina\*, it gives rise to an interpretation by ascribing a concept\* to it. The interpretation ascribed is known as the Phi\* phenomenon, a term introduced by Wertheimer\*. He believes the sensing of movement is an immediate experience that needs no further interpretation. The same interpretation is assumed when lines are exposed successively close together. Motion is a concept that developed because it was needed to explain experience, and when once the concept had been developed to explain real movement it was applied to the successive exposure of two lines.

*Summary.* Perception is becoming aware of objects as concrete wholes. Two approaches to perception\* are current at present. The more traditional regards perceiving as a process of constructing the notion of an object from sensations, memories, and movements. The second accepts the unit as it is given and is content to describe its characteristics and state some of the conditions under which they are found. Each approach has contributed to the present status of the theory of perception. The conclusions are not altogether incompatible. We need not evaluate the relative merits of the two theories.

The difference between a sensation\* and a percept is evident from the persistence of the brightness, color, size, and form of a percept under changing external illumination, distance and position. The construction effects can be seen in the perception\* of distance by the eye. For the eye, changes in muscles, double images, and different sensory qualities become the signs of distance. Analysis of reading shows how the arbitrary symbols of letters are first corrected in themselves and then arouse images\*



of the past and suggest abstract meanings as the eye runs over the line of print. Time and rhythm, seeing movement (real or artificial as in the moving picture) emphasize the importance of interpretation in perception. Illusions\* of all sorts are important as they are merely mistakes in construction, which emphasize that all perceiving is interpreting. In illusions, the normal processes take the wrong path and so mislead.

### TEST QUESTIONS

A. *True-False Statements.* Read each statement and decide as to its truth or falsity.

1. Perception and sensation are the same.
2. Perception is sensation plus meaning.
3. A series of elements unite into an object or Gestalt if they are not all alike.
4. One is aware of each element that enters into a percept.
5. If two of a series of elements are nearer to each other than to another element they unite more readily with each other than with the more distant element.
6. An object always shifts its color if illuminated by a colored light.
7. A shadow reduces the brightness of an object more if one cannot see the object that casts the shadow.
8. A pencil seems to grow smaller in proportion to its distance from the eye.
9. Position is an immediate consciousness that cannot be analyzed or understood.
10. Position is judged more accurately by the eye than by the skin.
11. The local sign has been assigned to the reflex movement that is made as one touches the point on the skin.
12. Distance of an object from the eye is appreciated because of direct awareness of the changes in the muscle of accommodation in the eye.
13. We always see an object as double, for it sends an image to each eye and each eye sends its impulse to the brain.
14. When one looks at the curtain cord in a window, all objects outside are seen in double images, and all objects in the room are also double.

15. One cannot distinguish between the nearer and the farther double images.
16. Shadows give an indication of the concavity or convexity of an object because the act of assuming a change in the direction from which the light comes changes the contour of the object.
17. Double images are more accurate than accommodation in estimating distance.
18. Perception never deceives.
19. A vertical line seems longer than a horizontal one of the same length.
20. Lines in the neighborhood of a figure seem to become part of a figure and affect its contour and size (Müller-Lyer).
21. One sees acute angles in their true size.
22. The ear is more accurate than the eye in determining the direction in which an object moves.
23. Periods of time longer than four seconds are estimated by means of the strains in muscles that have contracted as we wait for the end of the period.
24. As one reads, the eyes move regularly across the line so that perception is an uninterrupted process.
25. In reading, ideas or images from the past replace the words, and the words are seen in consciousness if not on the page.
26. Time is perceived during the interval rather than at the end of the interval.
27. Rhythm is always and entirely the result of differences in the intensity of the stimuli.
28. The Gestalt School as a general principle explains experience by reference to separate elements and to the connections between single elements.

B. *Completion Statements.* Read the incomplete statements and decide upon the words that would complete each statement.

1. Perception involves the addition of \_\_\_\_\_ to  
    . For the Gestalt theory it is \_\_\_\_\_

2. Reading is a process of transforming sensation from  
    into \_\_\_\_\_ by means of \_\_\_\_\_ .

3. Reading takes place during eye pauses numbering from \_\_\_\_\_ to \_\_\_\_\_ per line, and ranging from \_\_\_\_\_ to \_\_\_\_\_ in length.
4. Position on the skin may be appreciated for the wrist within \_\_\_\_\_ mm., for the finger tips within \_\_\_\_\_ mm.
5. Distance away from the eye is appreciated by \_\_\_\_\_, by \_\_\_\_\_ and by \_\_\_\_\_ considering only the changes in the adjustment of the eyes themselves.
6. Whether a sound is to the right or to the left of the head is determined by difference in \_\_\_\_\_ the two ears, and by difference in \_\_\_\_\_ in the two ears.
7. The Müller-Lyer illusion is explained by \_\_\_\_\_ with the \_\_\_\_\_.
8. Rhythm is produced by (1) \_\_\_\_\_  
(2) \_\_\_\_\_  
(3) \_\_\_\_\_.
9. When two lines \_\_\_\_\_ 6 mm. apart are exposed successively at intervals of \_\_\_\_\_ to \_\_\_\_\_, one line seems to move towards the other.
10. Very short intervals of time are appreciated by \_\_\_\_\_, moderate times to three seconds by \_\_\_\_\_, longer times by \_\_\_\_\_.

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## CHAPTER TWELVE

# Memory: Acquiring and Retaining Knowledge

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### WHAT IS INCLUDED IN MEMORY; METHODS OF STUDYING MEMORY

*Experimental Methods for the Study of Memory.* Many investigations have been conducted to ascertain laws\* of learning\* (using different kinds of material), to measure the rate of forgetting\*, to study means of recall\*, and reasons for the acceptance or rejection of the material that suggests itself during attempted recall, i.e., the phenomenon we call recognition\*. The studies have developed in accordance with both practical and theoretical interests. The student always desires to know how he can learn with the least effort and the greatest certainty. The psychologist is also interested in understanding the processes of learning involved. The earliest experimental task was to determine the laws governing the formation of connections between single elements. This experimental work made use chiefly of artificial or nonsense\* syllables, since these materials can have no connections with each other prior to the experiments\*.

*Methods of Experimentation in Memory.* Ebbinghaus\* devised nonsense syllables by taking the consonants in pairs and placing vowels between them, then eliminating any combinations that formed words or had too much resemblance to words. These combinations were drawn by lot and arranged in series. These series were read and re-read by the subject\* until he could recite them once without errors. Ebbinghaus determined the course of forgetting and various other facts of learning by relearning the



same series after intervals. He found that the amount forgotten could be measured by subtracting the number of repetitions required for the second learning from the number required for the first. By this method, one can also measure the comparative efficiency of different methods of learning. A second method is to have the subject learn the series by pairs, then to show him the first member of each pair and ask him to supply the second. The proportion of correct responses will indicate the accuracy of learning. The first method (or method of relearning) measures the potential retention; the second method measures actual retention, i.e., the amount available for immediate recall.

*Bonds Between Remote Syllables.* Ebbinghaus showed by his method that connections are formed, not merely between contiguous pairs, but also between syllables that are separated from each other by from one to seven units. Also he showed that there is considerable saving of time when the syllables are relearned in reverse order. In other words, a series is connected not merely by bonds between the contiguous syllables but also by units widely separated.

## LAWS OF CONNECTING UNITS IN SIMPLE SERIES; SOME PRACTICAL RULES

*Learning Varies with Number of Repetitions.* More practical was his proof that connections increase in strength in proportion to the number of repetitions, up to about twice the number required for the first correct reproduction. Repetitions beyond this number show some favorable influence but not in proportion to the time or effort expended. Nothing is ever learned to the point where it will never be forgotten, at least unless it be very simple material that has been learned repeatedly over a period of many years, e.g., multiplication tables, or one's native language. Extra repetitions of all materials are helpful.

*The Shorter the Series, the Easier the Learning.* A law that is of more restricted application is that the number of repetitions required increases greatly with the length of the series. One can remember five or six nonsense syllables or digits with a single repetition, but to remember eight units one will require eight or

ten repetitions, and to remember twelve units one may need six to twenty repetitions.

*Distribution of Repetitions Advantageous.* A series of laws were discovered which may be presented as rules of efficiency in learning. The most general rule is that one will learn with fewer repetitions if one does not attempt to learn any selection all in the same day, but makes a few repetitions each day for as many days as are needed. If we plan to have sixteen repetitions, we shall learn better if we read the series once every second or third day than if we use any other distribution of readings. Eight a day for two days is better than all in one day. The more one distributes the readings the better. The explanation is that traces\* increase in strength for some time after each group of repetitions. The more frequently opportunity is given for such increase, the less will be the work necessary for learning.

*Learning by Whole vs. Learning by Parts.* A second law that has held for most tests is that learning is quicker and more permanent if the material to be learned is not learned by parts but is read through from the beginning to end each time. If the average student is asked to learn a poem, he will learn the first two lines, then the second two, and, finally, will join them together. Then he will continue to learn other bits and will repeat the whole selection every time he learns a new part. This procedure means a very large number of repetitions of the first part, which is the easiest to learn, and relatively few of the latter parts. There is little continuity in the thoughts presented by the various parts, and there is confusion wherever a break is made in the connections among them. If the whole poem is read through from beginning to end, from ten to forty per cent of the time will be saved and retention\* will be increased. The saving is greater for trained learners and for individuals with higher intelligence.

*Active Repetitions.* A third law states that we learn more quickly if we make attempts to recite as soon as we learn a little of the material. Skaggs found that the best results are obtained if a selection is read through six or eight times and if attempts to recall are then alternated with passive readings.

*Intention to Learn an Aid.* Experiments have shown that if

during readings one has the intention to learn, learning is much more rapid than if one reads without such intention. Several experiments have been made in which subjects were asked to read lists of words for a purpose other than learning. Some were asked to go through and check all words in which certain vowels were present. This task entails careful reading, yet even after a large number of readings, it was found that the words had not been learned. Much less repetition is needed if there is intention to learn. There is evidence that intention to learn in order to prepare for a definite occasion will cause the material to be learned for that occasion and for no longer. Material brought together for a debate or for a court trial will be remembered for that purpose and will then be promptly forgotten.

*Associative Inhibition.* A factor in reducing the amount of effort in learning has been disclosed by the discovery that if an association\* has been formed with a syllable, more difficulty is found in connecting another syllable with it than if the first connection had not been made. This factor is known as associative\* inhibition. In practice it means that if a wrong association has been formed, more repetitions are required to correct it than are necessary to form a new association. Probably such rival connections explain why one cannot recall a name or a fact at a certain time, but finds that it has not been forgotten inasmuch as it may be revived on the next occasion. One may assume that a different association was active the first time and that this rival dropped out so that the original association could be recalled without hindrance.

*Uncompleted Tasks Remembered.* Zeigarnik showed that tasks which have not been finished are more likely to be remembered than are those which have been completed. In the Gestalt\* nomenclature it is said that an unfinished task is an open Gestalt and gives more tension than the closed completed task.

## RETENTION AND FORGETTING

*The Course of Forgetting; Theories of Forgetting.* The most striking fact about learning is that retention of the material learned is so short. Two theories have been held as to the process of forgetting. The more traditional one is that just as a scar

vanishes gradually, so a trace\* begins to grow dimmer as soon as it has been established. A second more recent theory is that memories disappear because of work done immediately after learning or because of confusion with other material. We may consider these theories later. For the present we can assert the striking fact that forgetting goes on very quickly at first and then more slowly. A number of experiments have been performed that agree on this point, although they differ somewhat

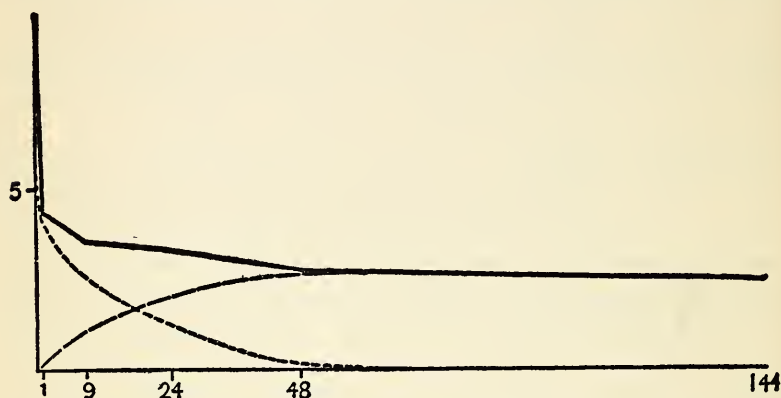


Fig. 30. Ebbinghaus curve of forgetting. Line shows amount retained after different hours. (Reprinted with permission of the Macmillan Company from Pillsbury, *Fundamentals of Psychology*, 1934, p. 497.)

as to the percentages forgotten. Ebbinghaus reported that half of the effect of learning nonsense syllables had been lost in an hour. Another observer found that half was lost in eight hours. Both agreed that more than twenty per cent of the effect still persisted after thirty days. A smaller percentage of the remaining trace\* disappeared in the interval between six days and thirty days than in the first eight hours.

*Meaningful Material Retained Better than Nonsense.* Sense material is more easily learned and less quickly forgotten than is nonsense material. A poem learned to the point at which it can be repeated once on four successive days will be remembered completely on the fifth day. Tests with classroom material show,



however, a curve of forgetting much like the curve for nonsense syllables except not so steep. Students who make an average of 75 per cent at the end of a course, will earn a grade in the low forties when re-examined without warning four months later. Much of what is learned is retained only in vague outline or in the ability to relearn the material with few repetitions when it is needed. We remember thoroughly only material that is often revived, such as the multiplication table.

*Reminiscence.* A phenomenon that seems to contradict the statement of the course of forgetting is found in the tests of material that has not been very well learned. This phenomenon is effective especially in the case of children. Ballard asked classes of children to learn poems, and tested them later, immediately after the last reading, to determine how completely they had learned them. When he tested the pupils after the lapse of from one to five days, he found that some children, throughout a period of from four to five days, increased in the amount they could recall. He argued that certain children gain in the amount remembered with the passage of time. He called this phenomenon *reminiscence*\*. His result has been confirmed by others and found to hold in many cases for adults as well as children. The theory is correct when applied to intervals of time in the case of immediate memory from single repetitions. One can recall more of a series of six nonsense syllables after thirty seconds than after ten seconds. The experimenter, Lehmann, could recognize more shades of grey after thirty seconds than immediately.

*Theories of Reminiscence.* Attempts have been made to explain reminiscence as due to increase in the chances for recall at the time of a second test. On the whole, however, it seems more in harmony with experimental facts to assume that there is on occasion some improvement in the strength of the trace\* after an interval. The gain is more pronounced in children than in adults, although adults show some gain. It is also more evident with simple sense material than with nonsense material. Longfellow's *Evangeline* showed a larger percentage of reminiscence than the *Ancient Mariner*.

*Retroactive Inhibition.* The experimental finding which suggested the theory that forgetting is due to an active process is



called retroactive\* inhibition. This is the name given the fact that learning another selection, immediately after having learned one selection, reduces the amount of the latter that can be recalled. The first experiments consisted in learning a series of nonsense syllables, and then immediately going on to learn another series. If the results of relearning the material a day later are compared with the results when the learner rests for six minutes or more, immediately after he has finished the first learning, it will be found that the new learning reduces the amount retained by twenty or more per cent. Recently we have shown that immediate retention of short series, that can be almost learned with a single repetition, can be reduced by from twenty to eighty per cent, if any hard work is done immediately after the learning, as compared with similar learning followed by a rest period of ten seconds. In this work with immediate or primary memory, the test was made after an interval of ten seconds.

*Theories of Retroactive Inhibition.* Two theories have been suggested to explain retroactive\* inhibition. The first, proposed by G. E. Müller\*, was that the work immediately following interfered with the perseveration\* or setting process. The perseveration process is the persistence of the photograph-like image\*, or the continuance of the activity of the stimulated neurones\*. If work is done, the activity of the neurones largely ceases. Müller's assumption was that associations\* are formed during this period of persisting activity. The other theory is a reference to the associative\* inhibition theory mentioned in the section on learning. This theory states that the new learning forms a second association with the elements of the first series, and thus reduces the strength of the first.

*Facts Favor Both Theories.* Experiments show that work reduces the amount retained. Some experiments show that learning similar material reduces retention more than learning dissimilar material. In immediate memory of words, mental arithmetic reduced the number of short words retained rather less than did learning other words. Learning nonsense syllables after learning short words reduced the amount retained more than did learning other short words, possibly because nonsense\* syllables are harder

to learn. There is no reason to doubt that both explanations may be true.

*Effects of Sleep on Retention.* If work after learning reduces retention, it would seem that sleep immediately after learning should increase retention most. Three investigators have confirmed this assumption. In one experiment, students learned series of nonsense syllables before going to sleep at night and, for comparison, at nine o'clock in the morning, before the daily routine of study. Both groups were tested one, two, four and eight hours after learning. It was shown that for the one and two hour intervals there was little difference between amount lost while sleeping and during work, but for the four and eight hour periods much more was forgotten during the waking period than during sleep; in fact little loss was found during sleep. The apparent loss after the one and two hour sleeping periods may have been caused by difficulty in waking for the work. Some who were tested forgot the next morning that a test had been made.

*Evidence for View of Forgetting as an Active Process.* The theory that forgetting is an active process of wiping out the trace\* by later work would imply that one would never forget were it possible to avoid all work after learning. Complete quiescence is impossible, but immediate sleep approximates the condition. Of practical import as well as evidence of the theory are the results of some experiments which indicated that one remembers more of work learned, just before going to sleep than of material learned before a period of hard work.

## RECALL

The test of learning\* and retention\* is recall\*. Recall is always by means of association\* with some incident that suggests the fact desired at the moment. The cue\* for recall may be any event that occurred at the same time as the recalled idea\*, or it may be only a part, what is called a reduced\* cue. In addition, one must have the right attitude\*. The question, "What is dissociation\*?," in a class in psychology, brings the answer, "A disturbance in personality," while in a chemistry class that answer would never be thought of. Usually the need for a bit of knowledge arises in an attitude or situation that is favorable to its recall. One may be

aware of the need before one has the cue or association that brings the specific idea. One may desire to name the man who first noticed the flight of colors and try several names before one hits upon Fechner\* and appreciates that this name is correct. One may have the cue but a wrong attitude and be led to a false conclusion, as when one sees 4 over 2 and is in the subtraction attitude when one should be in the addition attitude. Few rules can be given for improvement in ability to recall. Recall depends altogether upon a satisfactory suggestion and an appropriate context or environment. Usually, when recall takes place, necessity brings the cue, and the attitude corresponds to the need.

*Reproductive Inhibition.* The one experimentally determined law connected with recall is that when two facts have been associated with the same cue neither may be recalled when the cue is presented. This process has been called reproductive\* inhibition. It was first demonstrated with nonsense syllables, and constitutes the recall phase of associative inhibition (p. 231). If two nonsense syllables are learned in connection with a single one, A followed by B and then A followed by C, and A is shown later, neither B nor C is so likely to be recalled as if A had been connected with either B or C alone. Learning a series of false capitals of states or of false authors for books is more difficult for one who knows the right ones than it is for him to learn a list of authors of unfamiliar books or of capitals of unknown countries. Learning the right interferes with learning the wrong connection. More important is the fact that when a mistake has been made in the material learned it is more difficult to learn the correct statement than if the false one had not been learned.

*Temporary Forgetting Due to Inhibition\*.* If two different first syllables are learned along with a second syllable there is also interference. The second cannot be learned so readily as it could if there were but a single connection. Any change in the components of a group or series of facts or elements that are to be learned together makes learning more difficult. Such interferences may explain the failure to recall events that one knows perfectly well. One is asked for the author of a book and cannot answer. A short time afterward one recalls the name without difficulty. It is probable that when the question was asked a

second association was striving for mastery with the name desired. At the later recall, this second associate had dropped out because of a change in attitude.

## RECOGNITION

Final acceptance or rejection of tentative suggestions in recall is said to be due to recognition\*. One knows at once that a suggestion is wrong or accepts it quickly when it is right. The same process can be seen in the acceptance of an object or person as something that has been seen before. The name of a book will be

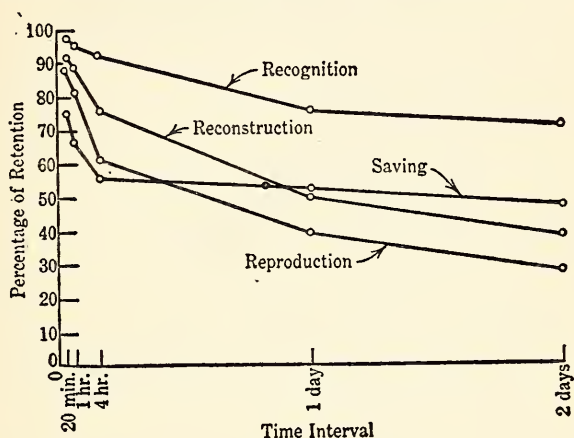


Fig. 31. Retention curves from C. W. Luh, *Psychol Monog.*, 1922, 31, No. 142, p. 22. (Reprinted with permission of John Wiley and Sons, Inc, publishers, from Boring, Langfeld, Weld, et al., *Psychology: A Factual Textbook*, 1935, p. 337.)

so accepted when some one else mentions it although one could not otherwise think of the name. Experiments show we recognize material that we have previously learned by means of many fewer repetitions than are necessary for us to recall\* it. If an individual reads twenty advertisements one day, and is asked the next day to select the same items when twenty new advertisements have been added, he will recognize many more items than he can recall. Ability to recognize decreases with time, at first



slowly, then more quickly; but the decrease is much slower than in the case of the ability to recall. (See Fig. 31.)

Recognition depends, as does recall, upon one's attitude. If we meet someone in a group in which we frequently see him, we are more likely to recognize him than if we see him in an entirely unfamiliar setting. Recognition is said not to be susceptible to retroactive\* inhibition, although some evidence for retroaction has been observed recently. The slighter effect is probably to be associated with the greater efficiency of recognition.

### THEORIES OF RECOGNITION

Some form of old associations is probably the cause of recognition. These associations may be motor, as when one makes the habitual and, therefore, the easier response to a familiar tool. Thus, we have adapted our movements to our knife or pen, so that the response is readier and more pleasant. In the same way an object may stimulate recall of events that have been associated with a familiar object. It has been suggested that these connections may give rise to the pleasant experience of recognition even when they do not themselves arise in consciousness. Often one can trace the process. If an individual is known to us, he may at first arouse no notion that we have seen him before. Then he seems vaguely familiar. At last a picture of the ship's rail against which we saw him supplements our awareness of him, or we recall his name or his occupation or both, and he is definitely placed. It is probable that the vague familiarity, that so frequently comes first, depends upon associations which are not completely aroused but still give rise to the feeling of "known-ness."

*Illusions of Recognition.* Not infrequent are cases in which the feeling of recognition arises when it should not do so. One feels that a street is familiar but is certain that one has never been in that locality. Such an incident is probably due to more or less close similarity to some other street that had been seen at some time in the past. The memories of the street are aroused enough to give the appreciation of familiarity, but not clearly enough to be recognized for themselves. In a form of mental disturbance, psychasthenia\*, these false recognitions are very common and are called by French physicians *déjà\* vu*. Psychasthenics also make



the mistake of failing to recognize people or events that are perfectly familiar. These lapses are explained as due to failure of associations to appear when they would in a normal\* individual, or to the appearance of similar associations which produce the "known-ness" attitude where it does not belong. Everyone makes an occasional mistake in recognition\*, in spite of the fact that recognition has greater fidelity than recall\*. Experiments show that mistakes in recognizing are about twice as likely to be mistakes of new items for old as of old for new. Recognition is the guarantee of accuracy in recall, and is more accurate than recall; but recognition is none the less subject to occasional error.

*Meaning as an Influence in Learning.* Meaningful material is much more easily learned than nonsense material. A single repetition will enable one to repeat not more than five or six nonsense syllables, but twenty or more words that make sense may be remembered. Retention\* of sense material is also much more persistent and accurate than of nonsense syllables. One may remember a specific meaningful event from the second or third year until the end of life, while a series of nonsense syllables may be forgotten, so far as immediate recall is concerned, the next day after learning them. The greater persistence of meaningful material is explained by the fact that such material makes sense because it is related to knowledge that has been previously acquired and has been organized. The latter part of the learning process is well prepared in advance so that the new related statement needs only to be fitted into the old pattern. This integration is quickly accomplished, and the new fact is long retained. The process of connecting a new bit of knowledge with one's background or system of knowledge is known as *assimilation*. Assimilation\* is an important phase of education.

### EXCEPTIONAL MEMORIES

Of interest in connection with ways of improving memory are certain individuals who learn with extraordinary ease and retain with great fidelity. Individuals of remarkable memories range from men of the highest intelligence to those who, except for the great ease of learning and accuracy of recall, are defective. Gauss, the great mathematician, is declared as a boy of three to

have corrected his father's statement of the week's wage of his employees. This achievement depended in part on memory. On the other hand, a boy in his teens with a mental age of nine learned the population of all towns in the United States of more than 10,000 inhabitants. These cases, so far as they have been studied carefully, have been found alike in having vivid imagery, in giving close attention, and in possessing what can be acquired by many, namely, a wide range of knowledge in a special field. R ckle, a mathematician who could remember long series of numbers after hearing them once, would relate the number to be learned to the list of prime numbers and dates that he already knew.

*Memory Systems.* Artificial devices have been used since ancient times to aid in recall. Most of them consist in relating an event or fact to be remembered to something else that is already known. To recall a date, digits can be arbitrarily related to consonants, and then words may be made by adding vowels that will have an association with an event to be connected with the date. Or arbitrary intermediate ideas can be put between two words that are to be related. Merely making an imaginary scene in which two words to be remembered are placed close together will make one recall the other when the first is presented again. These systems were described in considerable detail in some of the earlier books on the subject. Up to a point, such methods are helpful, but when elaborate, more time is required to learn the mnemonic system than would be necessary to learn the facts alone.

### MEMORY TRAINING

Much interest has been shown from time to time in the possibility and limits of increasing memory ability. A generation or so ago, there was a fairly general belief that memory could be trained through learning, just as a muscle can be strengthened by use. Some educational theories were built upon the assumption that one of the advantages of study is to train memory. Psychological experiments, beginning with those of William James\* in 1890, demonstrated that the increased ability to learn was limited strictly to the same kind of material that had been learned during the period of practice. Possibly the best statement was made by

Woodrow\* in reporting the results of an experiment he performed. To determine the effect on learning, he selected three groups of students of equal ability. One group learned six different kinds of material ranging from four verses of poetry to six to ten consonants, by reading the materials through once and repeating them. The group then rested for four weeks, and were tested again on their ability to remember a different selection of the same general kind. A second group learned the same material as the first, but then had eight periods of from twenty to twenty-eight minutes each, distributed over four weeks, for learning poetry and nonsense syllables. The third group spent 101 minutes altogether in learning poetry and nonsense syllables, and 76 minutes in listening to directions for learning. Each of the second and third groups had 177 minutes for learning and training. All three groups were then given the same test materials to measure the effect of learning and practice. The results showed that the training group, the group that received instructions on how to learn, improved most. The practice group improved in learning all material except poetry and prose, but the progress was slight in all types of subject matter.

The general conclusion is in harmony with conclusions regarding transfer of training (see p. 149 ff.). There is no single faculty or capacity of memory that can be trained by practice. It is true that learning any kind of material will develop habits\* that will make learning the same kind of material easier. Two weeks' practice may reduce by half the number of repetitions needed to learn a series of nonsense\* syllables. Learning material of any given kind may be more difficult after practice with a different kind of material. The difference in effectiveness of practice is attributed to the development of habits that may be applied to further learning. If the habits acquired in learning one kind of material are suited to another, they help; if they are not suited to the material, they hinder.

### RULES FOR LEARNING

A student may reduce the time required for learning by applying the rules given in this chapter. Woodrow\* gave his training group these instructions:

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- (1) Learn by wholes.
- (2) Test by attempting to recall after four repetitions.
- (3) Learn in rhythmic groups and group ideas.
- (4) Attend to the meaning, if there is meaning, and express it in other words.
- (5) Be alert and concentrate.
- (6) Be confident that you can recall.
- (7) Use secondary associations.

The student can use these rules for all rote learning. The suggestion that repetitions be distributed over as many days as possible can also be followed by the student to advantage. He will find it wise to avoid hard work for a few minutes after completing a task. If really applied, these suggestions will render learning easier and retention better.

### TEST QUESTIONS

A. *True-False Statements.* Read each statement and decide as to its truth or falsity.

1. Memory is a function of all living matter.
2. The revival of an old experience with the awareness that it is old constitutes memory.
3. Memory may be said to require five processes: learning, retaining, recall, recognition, and intuition.
4. Connections are formed only between contiguous items in a series.
5. The more remote two items are in a series the less likely one item is to recall the other.
6. The more slowly one reads a lesson, the more likely one is to remember it.
7. One can test the amount retained by relearning a selection and determining the number of repetitions required for relearning.
8. Learning is quicker if all repetitions are made at one sitting.
9. One learns with fewer repetitions if one reads a poem through from beginning to end without special repetitions of parts.
10. A long selection is learned with as few repetitions as a short one.
11. One is more likely to recall a finished task than an unfinished one.
12. One forgets more quickly at first and more slowly later.
13. Often a child, occasionally an adult, can recall more of a poem two days after learning than immediately.

14. It is not well to learn before sleeping for sleep reduces retention.
15. It is not well to turn to another serious task immediately after completing the learning of a selection. A six minute rest provides better retention.
16. If you learn an incorrect statement it does no harm, for you will be helped when you learn the correct statement of the same fact on a later occasion.
17. Recall is induced by mere desire to remember.
18. The attitude or "set" of the moment determines what any particular suggestion will recall.
19. Recognition is more accurate after a longer interval than is recall.
20. If you connect what you are to learn with what you already know, you will save time and avoid mistakes.
21. Recognition is just a feeling and cannot be explained.
22. Learning in school helps later learning only insofar as the material is the same or the methods to be used in later learning are the same as in school.
23. Memory is best in early childhood and declines with years.
24. Methods used by memory prodigies in learning give hints as to how the average person may improve his ability to learn.

B. *Completion Statements.* Read the incomplete statements and decide upon the words that would complete each statement.

1. Memory involves \_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_ and \_\_\_\_\_ .
2. Connections between items in a series can be demonstrated when they are separated by \_\_\_\_\_ units.
3. If repetitions are \_\_\_\_\_ times as many as are needed for a single correct repetition, they save time in subsequent learning.
4. Learning by reading through a whole selection may save 1/ \_\_\_\_\_ of the time required when the selection is learned by parts.
5. Distributing repetitions over different days saves time because \_\_\_\_\_ .
6. Two theories of forgetting are \_\_\_\_\_ and \_\_\_\_\_ .
7. Work immediately after learning has a \_\_\_\_\_ effect. This effect is called \_\_\_\_\_ inhibition.
8. Forgetting is a function of the \_\_\_\_\_ of the time.



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9. When a person recalls more a day after learning than he does immediately, the process is called . This process is prominent in the learning of and in individuals.
10. Recall is dependent upon and upon .
11. Recognition is due to .

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## CHAPTER THIRTEEN

### *Reasoning*

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#### THE DEFINITION OF REASONING

MAN NOT MERELY REMEMBERS OLD EXPERIENCES and applies old habits\* to new situations, but also changes old responses to meet new conditions and plans new instruments to meet his needs. This entire procedure is included in reasoning, and the term has therefore been defined as problem solving. Reasoning has also been defined as generalization\* or the process of seeing the common aspects in different objects or situations. Finally, a traditional definition states that reasoning is a means of proving the correctness of a conclusion. In fact, each of these factors is involved in every act of reasoning. Reasoning always starts with a problem, and this problem can be attacked only in the light of previous generalizations. Then the problem must be solved. Finally, the accepted solution must be shown to be true against all critics and to the satisfaction of the thinker himself.

#### THE NATURE OF GENERALIZATION IN CONCEPT FORMATION

Two processes lead to concept formation, namely *generalization* and *abstraction*. Generalization consists of grouping a number of similar objects into a class. Sometimes generalization depends upon recognition of the similarities, at other times upon failure to distinguish the differences among objects. The scientist seeks essential similarities among objects and then groups the objects according to their properties. A child calls all men *papa* because he overlooks the differences. Both methods have been

found to hold in experiments on concept formation. A study of the grouping of Chinese characters, when individuals were asked to learn them, showed that similar characters were classed under a common name and assigned to a common character or radical. Appreciation of the common element made learning easier. Memory tests by Bartlett and Crosland, using varied concrete objects, indicated that after the lapse of considerable time, similar objects tended to be combined because the differences between them could not be remembered.

*Abstraction.* Abstraction consists in recognizing the common aspects of a group of objects and treating this common quality as if it had a separate existence. Thus we first know only hot objects, but after dealing with a number of objects that are alike only in that they are hot, we begin to speak of heat as if it were something apart. These may be called abstract ideas\*, although appreciating them is probably an important factor in the formation of class concepts. Science\* can consider the conditions under which heat appears, without reference to the substance that is hot.

*Concept and Interpretation.* A concept\* is not mere generalizing. In forming a concept, one also constructs new theories\* as to the nature of the object. One interprets heat, for example, as a form of energy, and seeks to explain what it is in itself and how it acts. These theories must be tested by application, and if they work, the resulting ideas about the relevant aspect or quality improves our knowledge of the world. The development of these concepts is itself an active part of the thinking process. The real nature of an object comes to be known by developing a notion of it and then applying that notion to determine the kinds of problems the notion can be used to solve. Developing a true and adequate concept often aids greatly in solving a problem. Developing an accurate concept of the factors in the situation is an important step in solving the problem.

## REASONING AS PROBLEM SOLVING: HOW PROBLEMS ARISE

Of the various phases of reasoning, problem solving has been most discussed by psychologists. The process begins with the

presentation of a problem. Whenever there is a blocking of progress towards an objective, practical or theoretical, a problem arises. It may be purely physical, as when an automobile stops suddenly and refuses to respond when the starter is applied. A solution is attempted in the familiar ways. Is the gasoline tank empty? Is there a short circuit? Application of these questions involves the use of concepts\* derived from earlier experiences. If it is found that a wire is broken or a fuse is blown, the real activity of problem solving begins. Sometimes, as soon as one sees what is wrong, an old habit\* will suffice. The problem has been solved in the past. A walk back to the last gasoline station is required. Sometimes the use of a familiar object in a new way may solve the difficulty. A hair pin can be substituted temporarily for a fuse.

*Problem Solving as Trial and Error.* Many theoretical questions have been raised in recent years as to how a new idea\* is hit upon. An early analogy was taken from the trial\* and error responses of a cat when it is getting out of a cage. Most thinking requires a large number of attempts before the right idea comes. It is universally agreed that little can be done to hasten the coming of a thought that is to solve a problem. One must merely keep thinking and wait for an appropriate idea to appear. Most psychologists say the right solution is provided by an associative connection, but the connection has to be indirect because otherwise the process would be one of recall\*. According to our definition, reasoning is not recall but is the development of a new mode of response.

*Description of Problem Solving.* Wallas reports that great thinkers like Helmholtz and Poincaré solved some of their important problems many years after the problems first occurred to them. Both said, too, that the answer was likely to come at a moment when they were not immediately concerned with the problem. Helmholtz was most likely to hit upon a solution when he was walking up a gently inclined hill during a period of recreation. One chemist, who noted his own experience, said his best ideas came when he sat looking out of a window with his feet on a radiator. The important point on which thinkers of all



schools agree is that one cannot foresee when a correct solution is likely to appear.

*Problem Solving as Changing a Configuration.*<sup>1</sup> The Gestalt\* school takes a slightly different view of the mechanism by which the solution presents itself. They think of it as a process of transforming the Gestalt or of changing the aspect of the problem, of seeing it under a new point of view. A hair pin ceases to be something to hold tresses in place and becomes something that will conduct an electric current. Or in another problem that has been used for experiment, a pair of pliers suddenly becomes a weight that may be used as a pendulum bob. The Gestalt school, too, does not attempt to prophesy how or when the Gestalt will suddenly change its form. To the practical mind, it makes little difference whether an idea is suggested by some fleeting chance association\* or whether it arises from changing the interpretation of an object already present, inasmuch as the occasion for the presentation or change cannot be foreseen.

*Rules for Solving Problems.* A few rules have developed, from experiments, that may be of value in the process of thinking. Maier\* gave one group of students engaged in solving a problem the suggestion to change the direction of attack as often as possible. With another group of the same intelligence and size, he omitted the suggestion. He found that a considerably greater number of those who were told to vary the approach succeeded in solving the problem than did the control group. It seems that there is always a tendency to keep trying minor variations of the same method. The successful thinker quickly abandons one line of attack for another. It has also been found that men are more likely to solve problems than are women. Also, possession of high intelligence\* as measured by tests or by success in school does not insure ability to solve problems. Individuals of high intelligence, as measured by tests, succeed better on the average than do others, but some of high general intelligence are less likely to succeed than others who, though not superior according to test results, may solve a problem very readily. Tests of intelligence fail to measure originality because they depend too much on memory\*.

<sup>1</sup> Graham Wallas: *The Art of Thinking*, New York: Harcourt Brace & Co.,

## BELIEF, THE TEST OF A SOLUTION

Probably a more important aspect of problem solving than having ideas present themselves is the ability to appreciate an adequate idea when it appears. All authorities describe the process of problem solving as a series of trials. One seldom achieves the solution of a problem on the first attempt. The first suggestion is rarely accepted. Obviously, then, selection of the true hypothesis\* is quite as important as having the ideas suggest themselves. Belief in the truth or in the falsity of the suggestion is the immediate criterion for selecting. Belief can be considered descriptively in order that we may determine the characteristics that mark it off from other conscious qualities. It is more important for us to study the conditions under which belief arises and the factors that justify accepting it as a criterion of the truth or of the falsity of propositions. Belief attaches both to one's own conclusions and to statements of others.

*Signs of Belief.* The qualities of a statement that is believed as opposed to one that is not believed are first, that the accepted idea\* is fixed and constant, whereas the idea that is disbelieved is more indefinite and fluctuating. There is also a pleasant quality or aura that accompanies the accepted statement, while an unpleasant tension goes with the rejected statement. On the qualitative side, belief and disbelief probably belong together and doubt\* is opposed to both of them. Disbelief in one idea usually connotes belief in an opposing idea, and therefore tends to persist. Doubt is a fluctuation between belief and disbelief. First, a statement or a solution is accepted, then it is rejected, and, finally, there may be successive alternations of accepting and rejecting. This alternation is always unpleasant. The clarity with which a solution is perceived is also a factor in belief. The confused idea is generally rejected, and, as Descartes long ago asserted, the clearly thought notion tends to be accepted. It has also been said, and the statement agrees with observation, that one believes what one is prepared to act upon. In summary, what one believes is clear; is a stable unchanging notion; is something towards which one is prepared to act; and the process of believing is pleasant. Possibly all these qualities might attach to a statement that occurred

spontaneously, to one's self or to a suggestion by another and still the statement might not be believed. Such cases are probably rare, but the added factors leading to belief have thus far escaped analysis.

*We Believe the Pleasant.* More important are the causes that lead to the appearance of the phenomenal signs. Two of these are fairly certain. Lund showed by an experiment that there is a high correlation\* between what is regarded as pleasant and what is believed. He asked numerous students to grade the pleasure they would have from a series of propositions and then later asked them to designate the degree of belief\* they had for the same propositions. A sufficient interval elapsed between the two tests to prevent memory\* of one from affecting work on the other. When he plotted his results they showed a close correspondence between amount of pleasure and degree of belief. The coefficient\* of correlation was more than 0.80. Lund's implications are that we believe what is pleasant to believe, and then seek for proofs that will confirm the pleasant conclusion.

*Belief an Irradiation\* from Past Knowledge.* Another factor discovered by analysis of statements that are believed is the harmony between a statement and the earlier experience of the individual. A proposition which finds no contradiction in the accumulated experience of the individual arouses the belief experience. If we are aware of facts that oppose the proposition, we then reject it at once for a fully conscious reason. Sometimes the opposition between our previously acquired knowledge and the new suggestion is not so definite. The specific fact that would oppose the suggestion is not clearly recalled, but there is, nevertheless, hesitation in giving assent to the proposition. Even when the knowledge that is involved in accepting or rejecting is not specifically conscious, it does produce a halo\* effect that determines belief or doubt. This is evident from the observation that changing our fundamental knowledge will change our belief. Belief may also be changed by varying the aspects of knowledge that are brought to bear upon a proposition. Most argument consists in changing the attitude\* towards a proposition by changing the way it is seen. The spread of influence that produces belief is very much like that which produces recognition\*.

*Belief the Test of Problem Solving.* It would seem then that there are two fairly distinct phases of problem solving. One is finding a satisfactory plan; the other is being sure that it is satisfactory. To hit upon a new solution, a thinker must be versatile, have many new ideas and change them quickly. Acceptance or rejection of an idea demands stable judgment\*, considerable information, and the ability to bring a wide range of knowledge to bear in an unprejudiced way upon the problem. The two qualities might well be found in different individuals. A man suffering from manic insanity might be an ideal person to provide original ideas. He continually presents new ideas, some of them very strange. Occasionally, such a person has hit upon a great scientific discovery. If he were controlled by an individual who could discriminate adequately between the fantastic and the true suggestions, great results might be obtained. It is said that the success of some men in public life depends upon such partnerships. An individual with great originality but little ability to discriminate between the true and false may have a secretary without too great originality but with a balanced judgment. This combination might be as successful as, or more successful than to have a single person who possesses both types of ability.

### PROOF

After a solution has suggested itself and is believed, it is frequently, even generally, subjected to more formal proof\*. Proof is a process of creating belief. Formal logic\* from the time of Aristotle has dealt with the methods of proof. Some have confused the process of proof with the active processes of problem solving, but formal logic has never considered the discovery phase. The discovery aspect of thinking takes place before proof and cannot readily be put into words. This distinction was at first taken for granted; later, it was assumed by some that the method of proof should also be a method of discovery.

*Deduction.* Traditionally, three forms of proof have been recognized. The most used is deduction\*, or proof by reference to general principles that have already been established. Formal logic\* devotes most of its attention to devising adequate methods for the application of deduction. The main instrument of proof is



the syllogism\*. The syllogism, it will be recalled, consists of a major premise which states the accepted general principle that applies to the set of circumstances; a minor premise that relates the particular conclusion to the premise; and the conclusion itself. A familiar instance is:

All men are mortal	Major Premise
Cato is a man	Minor Premise
Therefore, Cato is mortal.	Conclusion

It is sometimes assumed that this represents the order of thinking, but really in most cases one hits upon the conclusion first, as a suggestion for the solution of a real problem, and comes to the major premise only when a means is sought for connecting it with established knowledge.

*The Syllogism as a Test of Proof.* The syllogism takes several forms but all are to be regarded as means of relating the new suggestion to the older organized knowledge. It has the advantage of putting into precise form the material that in ordinary discourse is presented in many varied and not easily discriminated forms. Woodworth\* found in experiments\* on thinking that many incidental statements tend to color the conclusion that will be drawn. This coloring constitutes what he calls the atmosphere effect. When the statements are given in simple propositions, it is possible to see at once whether the conclusion really follows from the premises. The many rules for different forms of the syllogism\* give us effective guides for the detection of false reasoning\* or of conclusions drawn on the basis of the halo\* effect.

*Deduction\* Draws Belief\* from Accumulated Knowledge.* The real explanation of deductive reasoning is to be found in the fact that the reference to generalized knowledge connects the new suggestion with the old knowledge and permits the attitude of belief to spread from the accepted to the new statements. Skill in reasoning is shown when an aspect of the problem under discussion is emphasized that can be seen to be in harmony with the older knowledge.

*Induction\*.* A second form of proof that is recognized by all and is widely used is induction. Induction is applied to proof that



is dependent upon actual concrete or empirical evidence. The simplest test of a suggested solution of a problem is to try it. If it works it is true. The difficulty with this procedure is that it may seem to work the first time, but when repeated fails. True induction needs to consider not one test but many, or to make a single test under absolutely standard conditions. Usually it is necessary to use both precautions, to make each test as standard as possible and to make several measurements to eliminate chance differences in materials, in individuals, or in method. Induction involves statistics\* in all the biological sciences and in many other fields of knowledge. Induction also involves references to accumulated knowledge for probable justification of the suggestion, and then leads to the accumulation of new knowledge for corroboration. Fundamentally, there is much in common between deduction and induction. The general principles of deduction were originally derived from experience. On the other hand, certain general principles are useful to control the search for related facts in inductive proof. Deduction and induction are involved in some degree in all proof. They are extremes of the same general process which consists essentially of connecting a new suggestion with organized old knowledge.

### TEST QUESTIONS

A. *True-False Statements.* Read each statement and decide as to its truth or falsity.

1. An inventor always solves his problem on the first attempt.
2. A difficulty encountered in actual practice suggests most problems.
3. Meaning is an awareness of reference that attaches to most percepts and ideas.
4. A concept is just a movement that is evoked by several different stimuli and so unites them in a common bond.
5. Judgment is a process of referring the problem to be solved to a single concept or class.
6. One can seldom trace the course of the mental processes that results in the solution of a problem.
7. All men are alike in their capacity to solve a problem, provided all have the same incentive.

- B. *Completion Statements.* Read the incomplete statements and decide on the words that would complete each statement.

1. Reasoning differs from recall in that \_\_\_\_\_.
2. One reasons when a \_\_\_\_\_ arises in \_\_\_\_\_ or in \_\_\_\_\_.
3. The stages in reasoning are (1) \_\_\_\_\_, (2) \_\_\_\_\_, (3) \_\_\_\_\_ and (4) \_\_\_\_\_.
4. A concept or abstract idea arises from \_\_\_\_\_ or from \_\_\_\_\_.
5. A concept aids thinking because it serves as a \_\_\_\_\_ of \_\_\_\_\_.
6. A problem is solved by \_\_\_\_\_ or by \_\_\_\_\_.

7. Selection of the right solutions depends upon .
8. Finding the right solution can be hastened by changing the .
9. Belief is characterized by , by  
and by .
10. Belief depends upon of  
with the suggested solution.
11. The syllogism is a method of , not of discovery.
12. Induction is proof by or by .

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## CHAPTER FOURTEEN

### *Action—The Control of Movement*

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#### HOW DOES ONE START A MOVEMENT ONE HAS LEARNED?

How A MAN MOVES and selects between different possible acts is an important problem. The fundamental movements are made possible by learning that establishes a connection between most sense\* organs and the appropriate muscles. Each sense organ is connected with many groups of muscles and not all muscles are appropriate to each stimulation of the organ. The stimuli\* that are excited when the most fundamental responses need to be used, are connected at birth with the muscles required. These responses are transferred by conditioning\* to other stimuli which also lead to the same responses. Connections with other responses are formed by less well-defined causes that we group together as the process of trial\* and error. In the adult there is a vast number of cross connections between sensory and motor nerves\*, and, what is more important, between patterns of stimuli and patterns of response. The cross connections automatically provide for many of the more complicated situations of life.

#### SENSORI-MOTOR\* AND IDEO-MOTOR\* ACTS

Granting these acquired and inherited connections, there is still a problem as to how the movement of a particular member is evoked at a given moment. The problem is partly one of how the specific situation is to be interpreted and how the correspond-



ing movement is to be initiated. Viewed from the standpoint of the man who acts, the immediate antecedent of action is some idea of the movement to be executed. Something in the environment suggests the act, or the end that is to be accomplished by the act, and dwelling upon that act or anything connected with it is followed by the act itself. When the act is preceded by an image\* or idea\*, we speak of an ideo-motor\* act. When mere sensation\* is the antecedent, we speak of a sensori-motor\* act. In most cases the antecedent is partly idea and partly sensation, so that the distinction is not clear cut in application, and in theory is not important.

*Movement Without Intention.* There need be no intention of moving provided the thought be definite enough. If you hold a weight supported by a string and watch a similar pendulum oscillate, the pendulum you hold will soon begin to swing. Looking intently at a spot may bring a movement of touching it when there is no occasion for the movement or the contact. It has been said that a movement results usually, even generally, from the arousal of the kinaesthetic\* images\* that are initiated when the movement is made. This is certainly not the only condition for movement, although in acts of skill a clear kinaesthetic image may increase the skill. Most cues\* to movement are reduced to some part of the act or to an image of the effect that is to be produced. One may picture the line that is to be constructed in writing or in drawing. When this picture is clearly presented with the intention of reproducing the outline, the line is drawn. In most cases, however, the cue is greatly reduced. One need think no more than of the end to be attained, and the movements necessary result at once. In speaking, one need only think of the words to be spoken, and they are at once uttered. At times one thinks only of the general point to be made. The words appear as the thought is formulated.

*The Inciting Idea.* What ideas\* precede a movement depends much on the familiarity of the movement. If it has been made often in the same connection and is appropriate to the need or purpose of the moment, the movement follows appreciation of any part of the occasion for the act. When the movement is new,

as in learning to paint or to use a lathe, each act is preceded by definite images\* that become clearer as skill is acquired. With still more complete familiarity through frequent repetition, less and less imagery usually precedes the act until it approaches the automatic. One seems to do little in connection with the movements as they are made.

### WHAT SENSATIONS GUIDE MOVEMENTS?

*Remote\* Sensations.* In addition to the influence of the idea in initiating a movement, two groups of sensations\* guide the course of each movement. James\* called these the remote and resident sensations. The remote sensations are those of sight which control movements of the hands or feet, and those of the ear which control speech or the tones of a violin. As one writes or draws, one constantly watches the line that is made and adjusts the movement almost automatically to the desired pattern. When one draws by looking at the image in a mirror, control is at first very difficult, but with much practice the movements are accurately adjusted. Control of the voice by the ear has become so automatic that one is seldom conscious of it. That such control is important is shown by the fact that the deaf cannot speak without prolonged special training, and then, imperfectly. Even when a man becomes deaf after learning to speak, his voice loses much of its intonation. For the individual of normal hearing, each time the sound changes its quality the ear starts an adjustment that brings the sound back to its correct quality.

*Resident\* Sensations.* The kinaesthetic\* sensations\* from the muscles of the moving member also control the contraction of the muscles. These are the resident sensations of James. The impulses from the sense\* organs in the muscles are carried to the cerebellum\* and other parts of the brain\* and brain\* stem, where they make connections with the motor nerves\* and aid in adjusting the strength and path of the impulses. The presence of these continuous sensations of movement is not usually noticed. The effect is demonstrated only by the lack of accuracy when the kinaesthetic paths are interfered with. In *tapes* or locomotor\* ataxia, the sensory paths from the muscles are destroyed and the

movements of walking, especially, are much less certain and easy than in the normal individual.

## HOW DOES ONE DECIDE WHAT MOVEMENT TO MAKE?

*Control of Ideas Is Control of Movements.* It follows from the principle of ideo-motor\* movement that control\* of ideas\* is also control of movements. Control of ideas follows the laws of succession of ideas, that is, the laws of association\*. One thinks of an act that needs to be performed or of the need, and this thought suggests the specific movements that will satisfy the need. In sensori-motor\* movements, attention\* to an object or to a point on an object directs a movement toward that object or point. Usually ideo-motor movement is supplemented by sensori-motor\* control when the act begins to be executed. The ideas are again controlled by the attitudes\* of the moment and the preliminary purposes. The execution follows immediately upon the idea. The degree of perseverance that will be shown when pursuing an act in the face of difficulties depends upon the various motives\* mentioned in the chapter on learning. When the motives are strong, great difficulties will be overcome; when they are weak, the individual will cease to struggle if success does not follow immediately.

*Will Is the Popular Name for the Sum of Motives.* The total mass of conditions of action, the control of ideas, the social pressure to attain the end, and the various motives that are effective in the individual at the moment of action constitute what man is accustomed to call will\*. Will is not a separate force or faculty, but is merely the sum of all these characteristics of the individual that lead to action and keep him striving toward the attainment of an end. What we call effort of will is here, as in voluntary\* attention, no more than the mass of sensations\* resulting from the contraction of muscles. Partly these sensations are from the muscles that produce the movements, but many are from the muscles that are called into action by overflow of the impulses to muscles not directly involved. The brow wrinkles, the fists are clenched, merely from conflicting movements that accompany

indecision, in advance of action as well as during its course. The sum of such kinaesthetic\* sensations we are accustomed to take as a sign of exertion, and we call them the feeling\* of effort\*.

### HOW LONG DOES IT TAKE TO MOVE?

*Reaction\* Times.* Many measurements have been made by psychologists of the time required to make simple movements. They were among the first psychological experiments\* and have contributed to a knowledge of the conditions of moving as well as to a knowledge of the times required for movements. They were begun for the practical purpose of learning why different astronomers varied in the measurements they made of the time of star transits. The first differences or personal\* equations, as they were called, between astronomers depended upon whether the observer emphasized the sight of the star and the wire in the telescope field, or the sound that gave the time signal. If the sound were emphasized, that seemed to come first; if the star crossing the central wire dominated, that seemed to come earlier. The difference amounted to a considerable fraction of a second. Later, a method was developed of recording the time of passage by pressing a button that recorded electrically the time of crossing. Further differences of calculation resulted from the different times required for the astronomers to move after the signal. This difficulty led to the investigation of the times required for response by each observer, and to the general study of reaction times as such.

*Times for Different Senses.* One of the first facts that developed was that there is a difference in the speed of reaction to stimuli arising from different senses. In general, pressure and sound are quick senses, while sight, smell, warmth and pain are slow senses. Measurements are made in thousandths of a second. Measurements are made on clocks that are started by the stimulus\* and stop when the response is made. This procedure insures accuracy to a few thousandths of a second. Below is given the range of times for the more important senses. Individuals show considerable differences, and the same individual will vary slightly from time to time, so that the results are averages\* of a number of responses.



Tactual sensations .....	110-170	thousandths of a second				
Auditory sensations .....	110-160	"	"	"	"	"
Visual sensations .....	160-280	"	"	"	"	"
Warmth .....	220-300	"	"	"	"	"
Pain .....	400-1000	"	"	"	"	"

*The Control of Reactions.* More important than the numerical results are the conditions under which the reaction\* times change. One of the first observations was that a preliminary signal decreases the time of response markedly. Allowing a period of about two seconds prior to the stimulus\* gives the shortest response. The period between the "ready" signal and the stimulus is used to adjust the sense\* organs and the muscles of response. If the time of preparation is too short, adjustment is incomplete; if it is too long, relaxation begins. The preliminary adjustment is almost as important as the stimulus in the execution of the movement.

*Compound Reaction Times.* It is also possible to measure more complex mental activities than these simple or sensory responses. One of the first measured was the time taken to discriminate between several stimuli. The observer was told that he would be given one of two colors and that he should react when he saw one and not react when the other was given. This method increased the time of response by about 20 thousandths of a second on the average. When more than two colors were available, the time increased. When red had to be reacted to, among ten possible colors, more than three times as great an interval was required for the response as when red was one of two colors. Still more complicated is the determination of the time required for choice of reaction when a different response is made for each kind of stimulus. In the usual experiment, a different finger is used for each color or other stimulus. Here again, the times increase with an increase in the number of different stimuli and responses. The times required for choice are but little longer than those required for discrimination\*.

When the member that moves is larger, the leg, *e.g.*, the time required to move it is greater. Measurements have been made of the time taken to put on the brakes of an automobile, and it has been found that the average time required is about eight-tenths



of a second. The time required for this response is highly important for determining safe driving speeds and the distances that should be kept between cars in traffic. Interesting to the student are the results of measurements by Miles of the time a football halfback requires to get started on a run. Here, beginning the response takes from .36 to .44 second. In all these practical applications, the value of being prepared in advance and of having as few alternatives of response as possible is as great as in laboratory experiments.

*Association\* Times.* More frequently used in practical tests are analyses of the times required for associations. To measure associations a word is shown the observer, and the time that he takes to supply a second word is measured. These times are more variable than most of the others, ranging from less than half a second to two or more seconds. In this experiment, the effect of setting a task and of the nature of the task set is very marked. If a pupil is shown a noun and is told to state the class in which an object corresponding to the noun can be found, the time taken is relatively short. More time is required to give another instance of the same class, and still more, ordinarily, to state a member of a class when a class name is shown. The greater the range of possible associations, the longer the time required. The influence of the task selected is striking, for the observer seldom thinks of a word that does not correspond to the conditions that are set.

### CAN ONE USE REACTIONS TO TEST SINCERITY?

*The Lie Detector.* The association time experiment has also been applied to determine the degree of emotion that is aroused by a word. When a physician seeks to know what complex\* or group of experiences is disturbing a patient with a mental disease, he shows the patient a series of words and asks him to speak the first word that comes to mind. He measures the time that elapses. If the association for one word takes a very long time, it is probably connected with the group of experiences that caused the disease. When words of a similar meaning all require long association times, an attempt is made to discover the related experiences by questioning the patient. The discovery may prepare the way for a cure. The same method has been applied to criminals

to determine whether they are guilty of a crime of which they are suspected. The police usually combine this method with records of circulation, of breathing and of the electrical changes in the skin. Even then the method has limitations, for an innocent person may show as much emotion on being charged with a crime as the hardened criminal who has actually committed one.

*The Source of Differences in Reaction Times.* The occasions on which we find differences in the times required for response vary greatly with the kinds of reaction. In the simple reaction times, most depends upon the time required to stimulate the sense organs. The mechanical senses of hearing and touch respond very quickly. In the eye, the light causes a chemical reaction in rods and cones, which requires much more time. Stimulation of the taste organs and of the organs of smell is also produced by means of a chemical reaction and is, therefore, slow. The compound reaction times all require the action of several nerve elements in the cortex\* before a movement can be made. The greater the number of possible responses and the less each has become habitual, the slower the response. We can only theorize as to the nature of the response in the cortex, but it is true that any increase in the complexity or in the number of possibilities of response lengthens the time of the reaction. The fewer the responses that may be made to a stimulus because of the nature of the task or because of the few habits connected with the stimulus, the shorter the time required for the act.

### THE COURSE OF WORK—FATIGUE

Closely related to work is the problem of its after effects. Popularly we are more concerned with the deleterious effects that are known as fatigue\*. Physical fatigue shows itself in the falling off in capacity. The runner slows down after ten seconds or so. A man can lift an eighty-pound weight a few times, but if there is no rest between lifts he cannot lift it again. Mental work also brings fatigue. Eight hours of writing renders the worker liable to increasing numbers of mistakes and decreases the flow of ideas. The question of how far fatigue should be considered in planning work and the most favorable periods for work, is important for the individual and for industry.

*Physical Fatigue.* Physical fatigue is due to changes in the muscle, in the connections between nerve and muscle, and in the nerve cells. Stimulation of the excised frog muscle produces incapacity to respond further. Before this stage occurs, the nerve plate, where impulses pass from nerve to muscle, ceases to act. Fatigue may also be due to reduction in the capacity of the nerve cell. Mental work, too, produces a decrease in ability to work. At times skeptics have questioned whether one really becomes fatigued mentally or is merely bored. Thorndike, one of the skeptics on the topic, asked a student, Miss Arai, to do mental multiplication of four-place numbers by four-place numbers from eleven in the morning to eleven at night without a break. Her results showed that at the end of the twelve hours she was still multiplying, although the time required for each problem had about doubled. Thorndike argued that this decline in efficiency was due not to fatigue but merely to boredom or disinclination to work fast. The student was sufficiently disinclined to be unwilling to repeat the experiment again, and consented to make only four repetitions of the original test. It seems fair to say the decline was due to real fatigue.

*Mental Fatigue.* That mental fatigue is real appears very probable from Painter's repetition of Arai's experiment. Painter began work at eleven at night after a hard week's work. During the first hour there was little subjective fatigue, but early in the third hour the mental process seemed no longer under voluntary control. Partial products could not be recalled or retained. By three o'clock he gave up and was helped to bed. He concluded that there was a limit, that came very suddenly, beyond which it was impossible to do mental work at all. Observations show that under incentive\* the individual can rally against marked fatigue, and can seem for a time to be at full capacity, but when the break comes it may be complete. One research worker on the effects of loss of sleep found that his subjects could pull themselves together to solve problems by means of logarithms when the numbers were given hallucinatory interpretations, and that their condition constituted almost a pathological\* state of fatigue. This capacity for effective work over short periods, in spite of deleterious conditions, complicates all measurement of fatigue.

*The Course of Efficiency in Work.* Studies of the accuracy and rate of work over periods of time show first a gradual improvement that is due to practice. The task that is to be performed, to provide data for the measurement of fatigue, is repeated often, before the experiment begins, to attain a maximum of practice; but, nevertheless, in any period of work the rate improves at first and then declines as a result of fatigue. The shift from increasing to decreasing efficiency comes at different times for different individuals and for different kinds of work. In a five-hour morning work period in a factory, the peak of output comes generally in the fourth hour. There is a drop again after lunch, then an increase to the peak of the day in the mid-afternoon, then a new falling off. Kraepelin\* suggested two other factors making for improvement of output. These are inertia\* and habituation\*. Inertia, as in the case of a physical body, means that the activity takes a little time to reach full momentum and also tends to keep going once started. The increase in efficiency through the early periods of work, especially in a thoroughly practiced process, would seem ascribable to this inertia, as much as to practice. Any rest period of more than a few minutes shows the same tendency. Kraepelin\* found that a rest of five minutes is better than a longer one, as in the longer one the loss of inertia more than counteracts the recovery from fatigue. Habituation\* is described as the process of getting set for a task. Adjustment to the work explains part of the improvement that occurs during the first minutes of a task. Once attained, the adjustment persists during the entire time of work. *Initial spurt* and *end spurt* have also been recognized. These are increased outputs at the beginning and end of a period of work.

## APPLICATIONS TO INDUSTRY

Obviously to know the most effective period of work is highly important for the management of a business. Many studies were made by a British commission during the first World War. The investigators found that more work could be done in an eight-hour day than in a twelve-hour day, or than in a ten-hour day. Even the incentive\* of patriotism could not overcome the factor of slower rate of work during the longer period. There is a lag



in adjusting the rate of work to the shorter day; but when the workers become adjusted they accomplish as much in the shorter period. It was also found that a six day week gave a larger output than a seven. There is a curve of work for the days of the week that corresponds to the curve for a single day. Monday is always a day of smallest output and most accidents. The peak is reached on Thursday with a falling off to Saturday. More research needs to be done on this problem before complete knowledge can be assumed, but in many industries a day of eight hours gives approximately the maximum output.

*Summary.* In general, starting a movement depends upon developing the right ideas\*, and the control of movement takes place by means of control of ideas. Movement follows at once on the appearance of an idea that demands an act, when the mental\* set or purpose requires an act. Persistence in carrying out a series of movements depends upon the motives that are present, upon social pressure and consequent recognition of the desirable character of the end to be accomplished. Study of reaction\* times reinforces the principle of the dependence of action upon stimulus\* and idea. A stimulus operating after directions have been given for a response makes the stimulus arouse a movement at once. The times of reaction vary with the time required to stimulate the sense\* organ, with the preparation for the act, with the complexity of the situation, and with the possibilities of acting.

## TEST QUESTIONS

A. *True-False Statements.* Read each statement and decide as to its truth or falsity.

1. A movement is always due to some stimulus.
2. A man moves just because he wills to move.
3. A movement is the result of keeping the idea of the movement, or of the end that is desired, constantly in mind.
4. One can think indefinitely of a movement without making it or any movement like it.
5. The initiation of an act is due primarily to an idea in a particular setting or context.
6. The strength of a movement does not depend upon the presence or character of an emotion.



7. A blind man can write as well as a man who can see.
  8. A kinaesthetic sensation, or a memory of such sensation derived from the movement when it was made earlier, is essential to moving.
  9. Resident sensations are sensations from the moving muscle that, through association, give the next phase of the movement its proper course.
  10. Remote sensations are sensations from any object not in contact with the body. They do not help in writing.
  11. A man's thought determines his actions.
  12. What we call effort is merely our appreciation of the demands of the community, or the sensations from muscular contractions that are made spontaneously during a decision.
  13. A reaction is too quick to be seen. Thought takes no time.
  14. Reactions to sound are quicker than to touch.
  15. The more the associations that are possible with a word, the longer the time required to speak any one associated word.
  16. If the subject is angry when association time is measured, the time will be shorter than when he is calm.
  17. Reactions to sound are quicker than to light.
  18. We can determine a man's guilt by the time he takes for different associations.
  19. Will is a real force in mind that makes us move.
  20. Decision in action comes from weighing all the factors and then emphasizing one by keeping it constantly before us.
  21. A golf ball always goes where one intends it to go, whether or not one's eye is directed towards the goal one intends to reach.
- B. *Completion Statements*. Read the incomplete statements and decide on the words that would complete each statement.
1. The incentive for movement is always a \_\_\_\_\_ or a \_\_\_\_\_
  2. Movement without intention is determined by \_\_\_\_\_ or by \_\_\_\_\_
  3. The course of a movement is controlled by \_\_\_\_\_ and remote sensations.
  4. A deaf man cannot speak because he cannot \_\_\_\_\_

5. A man with tabes cannot walk straight because he
6. Choice of movements is a choice of \_\_\_\_\_ or of \_\_\_\_\_
7. Will is the name for: \_\_\_\_\_
8. About \_\_\_\_\_ thousandths of a second is needed to move a finger after a sound stimulus is given; about \_\_\_\_\_ thousandths when a color is shown.
9. In any reaction, preliminary \_\_\_\_\_ shortens the time.
10. Choice times increase with the \_\_\_\_\_ of \_\_\_\_\_
11. Association times are increased by \_\_\_\_\_ or by \_\_\_\_\_

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## CHAPTER FIFTEEN

### *Personality*

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#### WHAT IS PERSONALITY?

THE MEANING OF THE TERM *personality*\* has long been the concern of laymen and scientists. The fact that various definitions have been offered shows that the nature of personality is still not completely known. Lack of knowledge exists chiefly because the scientific method was first applied to the study of the problem not more than thirty years ago. Today these definitions, however, can be included within one of two current interpretations. The first defines personality as the sum of the reaction\* tendencies (traits\*) of man. Personality thus becomes a general, all-inclusive term designating the organization, or co-ordination, of all traits which distinguish in degree one person from another. The second interpretation emphasizes the social aspect of personality and defines the term as "those characteristics of reaction most important in determining social adjustment."<sup>1</sup>

Both definitions incorporate the concept of *personality traits* by which is meant habitual and distinctive ways of behaving. Man's traits are his reaction tendencies. Both definitions, by implying that every person possesses personality, contradict the popular belief that a person either has or has no "personality." The first definition is used by those who study man's behavior in the experimental laboratory. The second is accepted by clinicians who

<sup>1</sup> Warren, H. C., Dictionary of Psychology, Houghton Mifflin, Boston, 1934. Pp. 372.

help man analyse his problems of daily adjustment in society. The two approaches, when combined, act as complements. They supplement each other. Because of the great theoretical and practical (economic and social) importance of personality it is not surprising that specialists in a number of fields today are co-operating in the study of what man's personality is like. The sociologist, the philosopher, the anthropologist, and the psychologist are all concerned each in his own way. For these investigators the following problems are of paramount importance: (1) what are the traits of personality and how shall they be designated? (2) how can tools for the measurement of these trait designations be constructed? (3) what factors influence the development of personality traits? (4) what is the integrated personality and how is this integration\* achieved?

### WHAT PERSONALITY IS NOT

Man has long been interested in the problems of personality classification and measurement. This curiosity is readily shown by reference both to early and modern interpretations offered to account for personality differences between two or more people. Early evidence of this interest is found in the writings of Hippocrates (460 B. C.) and Galen\* (200 A. D.). Temperament\*, they believed, is a balance between four humors or body fluids: phlegm, blood, black bile, and yellow bile. A preponderance of one of these would result respectively in the phlegmatic (indifferent), sanguine (enthusiastic), the melancholic (depressed), or the choleric (easily angered) temperament or disposition.

More recently several modern writers have attempted to classify man's reaction tendencies into two or more rigid groups or classes. These classifications are called *type*\* theories. Illustrative of this approach are the following.

(1) William James\* once held that personalities could be described as either "tough" or "tender minded."

(2) Carl G. Jung\* (1923) stated that people can be classed into two groups on the basis of their orientation toward the world. Those whose habitual reactions are primarily determined by objective factors rather than by subjective or well entrenched



personal biases, are called extroverts\*. Those whose traits are usually the results of subjective or personal evaluations of the world are called introverts\*. The extrovert is concerned, first, with the world. The introvert is concerned, first, with himself, and, second, with the world. Jung's classification has led to the rapid development of meter sticks for the measurement of *extroversion-introversion* as a trait\*. Evidence indicates that scores earned on these tests approximate a normal\* curve of distribution. The majority of people earn scores which cluster about the middle of the scale. These people are often called ambiverts\*. They possess degrees of both introversion and extroversion. Introversion-extroversion is thus a single trait rather than two, as Jung first assumed.

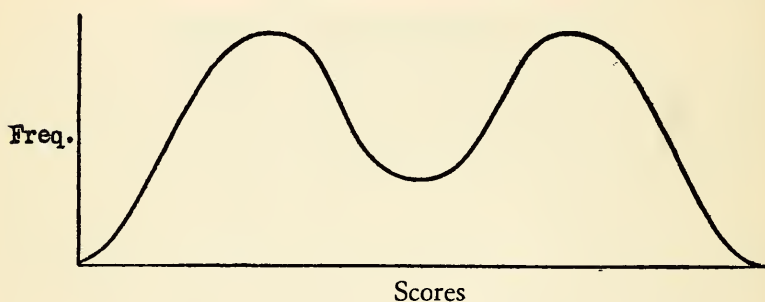


Fig. 32. The bimodal curve. This curve is rarely obtained in psychological investigations. (Reprinted with permission of Scott, Foresman and Company, publishers, from Ruch, *Psychology and Life*, revised edition, 1941, p. 451.)

(3) The psychiatrist Kretschmer\* (1925, 1931), in diagnosing and treating cases of insanity, proposed a threefold classification of personalities on the basis of physical characteristics. This theory, based upon the observation of mentally ill patients, classified people into the *pyknic*\* (roly-poly individuals in body build), the *asthenic*\* (lean, slender, underdeveloped individuals), and the *athletic* (muscular, well built persons) groups. Kretschmer, next, studied the personality characteristics of those normal and abnormal individuals who conformed in physiques to this three-

fold classification. He reported that the emotions and moods of the pyknic were definitely different from the dispositions of his asthenic and athletic (sometimes termed together as the leptosomes\*) subjects.

Accordingly, Kretschmer classified normal individuals on the basis of temperament into schizothymes\* (quiet, reserved, introspective individuals) and cyclothymes\* (energetic, lively people). Those who possessed these rival characteristics to an exaggerated degree were termed respectively schizoids\* and cycloids\*. Measurement of many personalities, however, shows that bimodal\* distribution curve (see fig. 32) does not obtain when emotionality as a trait\* is quantified. The unimodal curve is yielded. This finding suggests, as in the case of introversion and extroversion, that a personality trait is a quantitative variable\* and exists in different degrees from individual to individual. People cannot be grouped into types on the basis of their physiques and emotional reactions.

(4) Jaensch\* (1930) has concluded that the personalities of children can be grouped into one or the other of two classes on the basis of the nature of their eidetic\* imagery. He finds that children who look at a picture, for example, can, at a later date, project an image\* of this experience (mind picture) into space. By means of this projected mind picture, seen again as clearly as we see a photograph, the children are able to answer questions about the picture with an accuracy far beyond mere ability to remember. Jaensch believes that all children, to the degree that they possess eidetic imagery, can be classed either as *B-type* or *T-type*. Those of the *B* group are able to recall easily and at will the photographically clear eidetic images, while those of the *T-type* possess little if any control over the appearance and manipulation of the mind pictures. Jaensch assumes each type is related to the function of different endocrine\* glands. This assumption, however, has not been verified by physiological and medical research. Although each image "type" is assumed to accompany different personality characteristics, little support for this type theory has been found. Children, nevertheless, are known to differ in degree in the possession of eidetic images.

(5) Eduard Spranger\* (1928) has developed a classification of

men on the basis of their habitual values, or their ways of looking at the world. This approach differs from other type theories by classifying typical ways by which different men can interpret daily events. Its aim is to classify values rather than people. These value-groups Spranger calls the *theoretical, economic, religious, social, political, and aesthetic* or artistic. Allport\* and Vernon have developed a standardized\* test by which to measure the way or ways in which people evaluate the world. Scores earned on this test show that people do envisage situations in line with Spranger's descriptive grouping of primary values.

Type theories generally require that either bimodal\* (fig. 32) or multimodal\* distributions\* of scores result when random\* samplings of men and women are given standardized tests. The administration of carefully constructed meter sticks has yielded consistently, however, the *unimodal* curve. For this and other reasons, type theories of personality are considered invalid. Their value lies primarily in having stimulated the development of tools with which to quantify man's traits of personality. The type theories are discussed in psychology because they occasionally help students discard similar popularly conceived notions about what personality *is not* and *is*. Personality cannot be classified into rigid divisions. It is the sum of man's traits, each possessed in degree.

## THE ORIGINS AND NATURE OF PERSONALITY TRAITS

A trait is a name or symbol which stands for highly similar responses made by an individual. The fact that these responses are relatively much alike from one situation to another makes for a degree of consistency in man's daily life. The person who is said to be "genial," for example, is responding much the same in different situations. If this were not the case his acquaintances would use another symbol to characterize this aspect of his behavior. Each trait is thus elicited from time to time by a series of not strictly identical stimuli. This fact shows that a consistent response pattern, or reaction tendency such as "geniality," is a generalized one. It is a reaction to common elements present in a wide variety of different stimulating situations. A trait is, there-

fore, not a thing. It is a name which stands for and aptly describes a *generalized habit*. This trait-habit functions readily and often. It, like any habit, makes for consistency in behavior.

Traits, as generalized habits or reaction tendencies, can be accounted for in terms of the following specific factors: (1) heredity\*; (2) learning\*; (3) maturation\*.

First, traits are determined by heredity to the degree that characteristics of body tissues are determined by the genes\* and chromosomes\*. The protoplasmic properties of *irritability* of tissue, *conductivity* of nerves, *contractility* of muscles, *modifiability* and *integrative* functions of the central\* nervous system in man are the fundamental "givens" in life. Inasmuch as people differ from birth in structure, differences in the degree to which these characteristics are possessed play roles in the determination of traits.

Second, traits depend upon the influences of the internal and external aspects of the environment. The environment determines the kind of man's responses. The nature of the generalized habits is thus environmentally conditioned. By means of stimulating situations within and without the body man learns to behave in definite ways. With continued opportunity for practice these new ways of responding become more and more generalized. They come to predispose an individual to react in characteristic and prescribed ways. At this stage in learning a person might be said to be "genial."

Third, the increase in complexity of structure (maturation) during infancy\*, childhood\*, and adolescence\* provides those structural changes which make possible increased capacity to learn and to profit from experience. Learning\* and maturation\* are two highly influential factors which interlock in providing the processes for the development of generalized habits or traits from the more basic reflex-like reactions present at birth. The psychology of trait\* formation is the psychology of learning\* and habit\* acquisition. The biology of trait formation is the physiology of learning.

John Watson\*, the founder of the School of Behaviorism\* in modern psychology, is credited with having first emphasized the role of learning by conditioning\* in personality development. His classical experiments (1920s) consisted, by way of illustra-

tion, in the presentation of a rabbit to an infant. Accompanying the rabbit was a loud sound. The unlearned response to the sound stimulus\* was judged by Watson to induce fear\* in the baby. With continued presentations of the paired stimuli, the rabbit and the sound, the rabbit alone shortly elicited the fear response. Watson's studies showed that man's emotional responses are conditioned\* or learned responses. Accordingly, Watson has tried to account for all traits of personality on the basis of learning. It is now clear why *social conditioning* is considered today as the most important factor in the development of personality traits. Learning by conditioning plays a more influential role than do the biological determinants in the growth of personality. Both, however, are essential.

The number and nature of a person's traits have not been agreed upon. Several investigators have proposed lists of trait-names. Any one of these lists may or may not be found, with continued research, to be valid. The lists do, however, serve two purposes. First, they aid us in our introductory study of personality, and, second, they provide a basis for experimental analysis for those engaged in the study of traits. One of the best known lists is that formulated by F. H. Allport (1924) and modified in 1928 by Dashiell. These basic variables in personality follow.

TABLE 3  
SOME PERSONALITY VARIABLES<sup>2</sup>

- I. Physique
  - Size, strength, health, beauty
- II. Intelligence
  - General
  - Special aptitudes
  - Knowledge equipment (habits of perceiving, discriminating)
- III. Motility
  - Hyperkinetic versus hypokinetic
  - Impulsive versus inhibited
  - Graceful versus awkward

<sup>2</sup> Reprinted with permission of Houghton Mifflin Company from Dashiell, *Fundamentals of Objective Psychology*, 1928, p. 552.



- IV. Temperament (Emotionality)
  - Quickness
  - Intensity
  - Stability
  - Emotional attitude
- V. Motivation (Self-expression)
  - Directions
  - Focalization
  - Extroversion-introversion
  - Ascendance-submission
  - Methods of adjusting to difficulties
- VI. Sociality
  - Social perceiving
  - Socialization of habits

(1) *Motility*\*. Man's characteristic way of responding (moving about) conforms to the definition of a trait. Some people, to illustrate, are more active than others. Some are awkward. Others are more graceful. Some are relatively inhibited and slow to action. Others are more impulsive. The characteristic way a person moves (his gait, for example), constitutes his trait of motility.

(2) *Emotionality*\*. The speed and strength of emotional responses constitute a trait of personality. Some, for example, are easily angered. Others, slow to anger, eventually become more intensely upset than those who anger readily. Thus, the length of time required to elicit emotional reactions is still used today as a basis for describing characteristic reaction tendencies of an emotional nature. It is to be remembered in this connection that Hippocrates and Galen\* suggested this fact in their classification of the four temperaments. Some men and women, in addition, are relatively calm from day to day. Others show frequent "ups and downs." These people are less stable than the more calm individuals. *Emotional instability*, therefore, implies that one's emotional responses vary from day to day and from situation to situation. Everyday expressions bear out these facts. ". . . is a moody person" is illustrative. Man's *emotional sensitivity* is thus a trait of personality.

(3) *Self-expression*. Characteristic ways of expressing one's self conform to the definition of a trait. There are three characteristic ways by which this self-expression may be exhibited. First, *extroversion-introversion*\*, as a trait, characterizes the way in which an individual expresses himself in response to external stimuli. Some people, for example, show relatively greater concern for the affairs going on about them (extroverted reactions) than do those primarily concerned with their own interests and wants (introverted reactions). Second, some people are more *dominant* or *ascendant* in trying circumstances, while others are more *submissive*. *Dominance-submission*\*, as a characteristic way of expressing one's self, is a trait and can be measured. Third, man acquires characteristic ways of overcoming frustrations\* and resolving conflicts\*. The ways of adjusting to difficulties in life become habitual with practice. These *adjustment*\* *mechanisms*, as they are called, include, for example, adjustments by sublimation\*, rationalization\*, compensation\*, and projection\*. Characteristic ways of adjusting to conflicts and frustrations are discussed in Chapter VI.

(4) *Sociality*\*. People differ in the degree to which they conform to laws and customs of their society. Some always abide by the rules established by the majority. Others rebel. Some individuals perceive more readily and clearly the potential effects of their plans upon others and are guided accordingly in what they do and say. Characteristic ways of responding to social conventions and of getting along with others constitute the trait of sociality. In addition, Allport includes *intelligence*\* as a trait of personality, and Dashiell adds *physique*. Those who accept these aspects of man as traits often accept the social interpretation of personality. This interpretation is accepted because, to illustrate, the factors of how an individual "appears" (or "looks") and how "bright" he seems do help determine his social effectiveness. It is clear that the way we define *personality* and *trait* determines to a large measure the nature of the list of trait-names.

## METHODS OF MEASURING PERSONALITY TRAITS

Tests which have been constructed for use in the measurement of traits are called personality tests. The first ones in general use

appeared during the period of the World War (1917). The methods used in the construction of these standardized\* experiments have emerged from the more fundamental methods of observing and reporting.

### Methods Used in the Study of Personality

<i>Method</i>	<i>Major characteristics</i>
The questionnaire	The subject truthfully answers questions presented in printed form under standard conditions.
The rating scale	Traits are rated in terms of clearly defined standards by trained judges or by the subject himself (self-rating).
Behavior sampling	The experimenter observes the subject without making his presence and purpose known.
Clinical method	Although any one of these methods may be used advantageously in the behavior clinic the word association method (Jung), the Rorschach Ink-blot test, and Murray's Photograph Technique are also often administered under controlled conditions.
Interview method	Questions may be stated verbally by an examiner. The interview may be standardized (formal) or informal in technique.

One method of measurement is known as the personality questionnaire\*. It consists of a series of carefully worded questions concerning the subject's likes, dislikes, activities, and beliefs. Each question has been presented previously to a large sampling of subjects, hence one's score can be compared with the scores earned by many others. The first of this type, a general maladjustment test, was constructed by Woodworth\* in 1918 (*The Psychoneurotic\* Inventory*) to select those soldiers who were likely to undergo a "breakdown" under gun-fire. Since 1918 several other tests have been constructed to measure specific traits rather than to test general maladjustment as Woodworth's scale attempted to do. *The Bernreuter\* Personality Inventory* (1931) was de-

signed to test several traits (neurotic tendency, self-sufficiency, extroversion-introversion\*, and dominance-submission\*). Results from these and other questionnaires indicate clearly that a given trait among a group of subjects is not all or nothing, but is a quantitative variable\* to which the measurements of central\* tendency and scatter\* are applicable. One's score, therefore, must always be interpreted in terms of the group of which one is a member.

The rating\* scale is occasionally used in the measurement of personality variables. These scales, when administered, demand, however, that the trait to be rated by the judges be clearly defined. The scales must also possess clearcut steps or points by which the rater can readily indicate the degree to which his subject possesses this trait. Psychologists agree that for reliable rating at least eight judges should be used. To counteract the "halo\* effect," ratings on different traits by the same judges should be made only after several weeks have elapsed. By the "halo effect" is meant the influence that the rater's other ratings about the same subject may have upon his evaluation of a new trait to be marked. If a subject makes a poor appearance a rater might rate the man low on his "use of language." The rating method is frequently used in schools and in industry to determine the relative ranks\* of pupils and employees on specific traits such as honesty, ability, skill, and co-operation.

The behavior\* sampling method is a third method used in the study of personality. The unobtrusive observation of what a subject does under controlled and standardized conditions is used in the study of personality development of children and adolescents. One outstanding application of this method was made by Hartshorne and May (1928) in their inquiries into character education. These observers recorded cheating, stealing, and lying responses among children in school, at home, and at play. The results, in general, showed that these *character\** traits did not form a *cluster* of traits. Rather the entire situation appeared to determine whether a child cheated, lied, or stole. Children from high socio-economic levels cheated less than others less fortunate than themselves. Training, cultural background, and the present

stimulating situation acted as determiners of these character traits in the specific instances studied.

The word association method (association\* test) is sometimes used under particular circumstances. The method, originated by Jung\* in 1910, involves the presentation of a series of stimulus-words to each of which the subject responds with the first word that occurs to him. Since thoughts are controlled by stimuli and since frequency\*, recency\*, and vividness\* of past experiences predispose their recall\*, this method affords information concerning man's habitual thought patterns. Kent and Rosanoff (1927) used this method in their studies of the thoughts of insane\* and normal\* adults. They presented a list of 100 stimulus-words to 1000 adults and calculated how often each word brought out an ordinary or commonplace (such as table-chair) response. Insane patients made far more individualistic responses than did the normal adults. The word association method does yield information about the emotional, social, and economic experiences of man as reflected in his thought processes. A modification of Jung's original method is the Ink-Blot\* Test devised by Rorschach in 1921. This test consists of a series of ten different ink-blot, some in colors, printed on cards of uniform size. Each subject\* reports his answers to the question, "What could this be?" The answers, based upon what the ink-blot suggests or reminds the subject of, have disclosed trends in thinking and have shown the existence of habitual modes of response. Murray (1938) has devised a procedure to measure in still another way a person's trend of thinking. This method consists in presenting one at a time a series of carefully selected photographs of different situations. The subject is asked to develop in his own words a story about each picture.

These three techniques developed by Jung, Rorschach, and Murray are similar in certain respects and dissimilar in others. They are alike in that each relies upon the introspective\* method of observation in its analysis of personality traits. They are dissimilar in that the Rorschach and Murray techniques are relatively free from conventional meanings usually associated with the stimulus-words used in Jung's free association procedure. Ink-blot and pictures are, therefore, believed by many clinicians to yield more pertinent data concerning habitual thought pat-



terns than the association tests by Jung. All three methods, however, are used, upon occasion, in the study of personality and in the analysis of emotional "complexes\*."

The interview\* method makes use of *direct questioning* in the study of man's generalized habits. The personal interview, *standardized* (same questions asked different subjects under identical conditions) or *informal* (conversational period with the subject), is used frequently for obtaining case\* histories in psychological clinics and for the selection of industrial employees. To be reliable\* and valid\*, the interview must be motivated\* and uninterrupted. Records should be made at once to counteract the memory error (forgetting). Unless several investigators interview the same subject, the results are not reliable.

If intelligence and physical characteristics are accepted as personality variables\* (Allport and Dashiell), numerous standardized experiments are available for the measurement of general and special abilities. These meter sticks have been discussed in Chapter V, which deals with intelligent behavior. For the quantification of physical attributes various measures of height, body weight, head size and shape are available. Scores earned on these tests are then compared with the degree to which the majority of people in a selected culture accept or reject individuals possessing these physical characteristics.

## PERSONALITY TESTS AND HOW TO USE THEM

During the past twenty years a large number of tests employing different methods for the measurement of traits of personality have been constructed. To list and describe each is both impractical and unnecessary. The following are representative samples of those available for administration in clinics, industrial organizations, and educational institutions. Thurstone\* (1929) has constructed a psychological test for gauging emotional stability. This *Personality\* Schedule* differentiates between persons who are easily upset (less stable) emotionally and those who are less easily disturbed (more stable). The *Willoughby Emotional\* Maturity Scale* (1931) measures how well a subject, for an individual of his age level, controls his emotional reactions. A man of twenty-five who is rated as childish in terms of the items of the

Willoughby test would be called *emotionally immature*. The *Bell Adjustment Inventory* (1934) measures the degree of maladjustment shown by high school and college students in relation to home, health, social, and emotional conditions. The *Strong Vocational Interest\* Schedule* (1927) measures the nature and degree of occupational interests exhibited by young men and women. The *Allport\* Ascendancy-Submission\** test (1928) measures the degree to which a person shows degrees of dominant and submissive reaction tendencies. The *Allport-Vernon* (1931) *Study of Values* quantifies the values envisaged by a person in his interpretation of society. Terman\* (1936) has devised a test for the measurement of the degree of masculinity-femininity shown by a member of either sex. These and many other psychological tests of the questionnaire\* and rating\* scale types are used today in the analysis and control of human behavior\*.

The scores earned on questionnaires and rating scales must be interpreted with caution. First, the reliability\* of the test should be known. If the examination fails to measure consistently, little weight can be given to the score earned. Second, the validity\* of the test, though sometimes incompletely known because of the dearth of techniques by which to validate personality questionnaires, should be considered. If psychologists accept the test as a relatively valid method, more credence can be attached to a score earned on the test than would otherwise be the case. Third, a subject to whom a personality questionnaire is administered, must tell the truth. Falsification of answers results in a meaningless score. Fourth, a single item selected from a battery\* of test items is never in itself sufficient to warrant a generalized conclusion concerning one's personality. For this reason popular magazine articles dealing with "personality" must not be taken seriously by those who answer a few questions contained in the articles. "Personality tests" in popular magazines are both incomplete in content and improperly administered. Just as tests of intelligent behavior are tools which must be used under prescribed conditions, so, too, must the personality questionnaire and rating scale be carefully administered and interpreted.

## FACTORS WHICH DETERMINE THE NATURE OF PERSONALITY TRAITS

1. *Cultural*. Man's personality traits are determined, in part, by the demands and aspirations of his social group. Culture\*, in turn, is determined by man's ability to profit from experience, by human needs resulting from geographical position (for example, on the desert or in mountainous country), and by social determiners in the form of heritages handed down to us by the preceding generation.

2. *Physiological*. Personality traits, in part, are determined by the basic drives\* (such as hunger, thirst, and sex) to action. Man's adaptations to these basic urges (needs) also determine his traits of personality. Glandular secretions and changes in glandular balance, which alter the blood chemistry, likewise affect personality. Disorders of the endocrines\*, those glands secreting hormones\* (chemical substances) directly into the bloodstream, produce abnormalities\* in behavior\* and in physical appearance. The rather infrequently met but best known effects of endocrine disorders are related to the following glands\*.

The thyroid\* gland is located in the throat. Under-secretion in youth induces mental deficiency and physical abnormality called cretinism\*. This condition of hypothyroidism\* may be improved by early administration of a thyroid extract. Hypothyroidism produces myxedema\* in the adult and is characterized by lowered physical energy. Hyperfunction\* of the thyroid gland induces exaggerated motility, nervousness, and heightened body consumption of fuels (high rate of metabolism\*).

The pituitary\* gland or hypophysis is located at the base of the brain. This gland is composed, briefly speaking, of two lobes\*, the anterior\* and the posterior\*. The anterior lobe regulates body growth and stimulates other glands (such as the cortex\* of the adrenal\* gland and the gonads\*) for the development of primary and secondary sexual functions. Oversecretion of this lobe during childhood\* results in gigantism\*. Hypersecretion in the adult produces acromegaly\*, a condition characterized by renewed growth of the digits and by a general comic, bulbous

physical appearance. Undersecretion of the anterior lobe in childhood produces dwarfism\*. The functions of the posterior lobe are

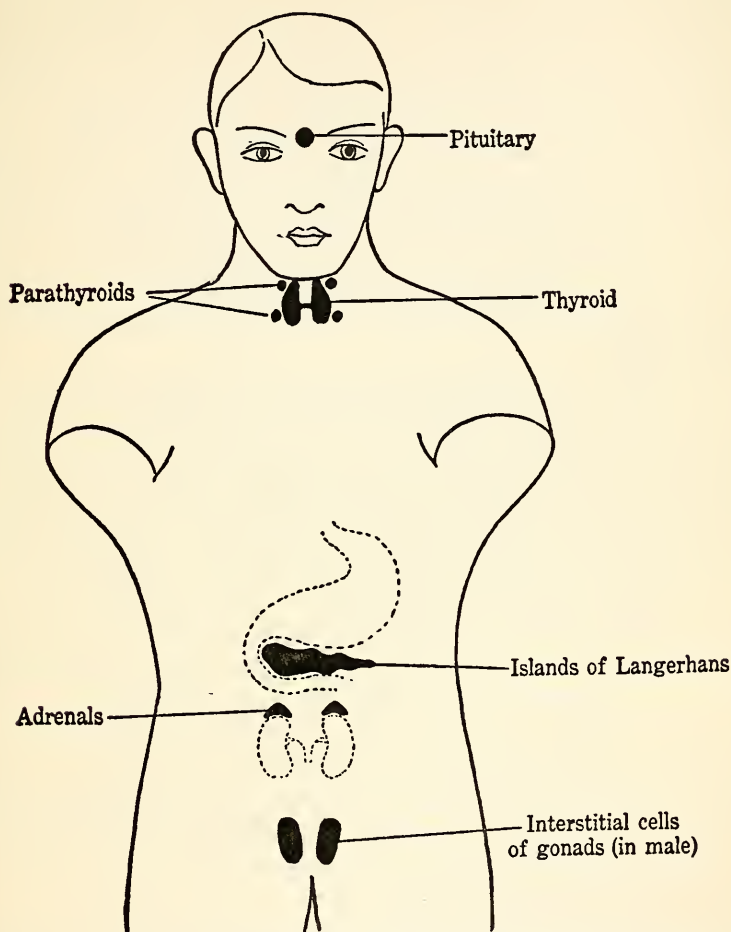


Fig. 33. Diagram showing the location of the endocrine glands. (Reprinted by permission of Harper and Brothers from Young, Stebbins, and Hylander, *A Survey in Biological Science*, 1938, p. 172.)

not well understood, although, it is believed, undersecretion results in excessive fat (obesity).

The adrenal\* glands are two in number and are located adjacent to the kidneys. The glands secrete adrenin\* into the bloodstream from the medulla\* (central cores of the glands). From the cortex\* (bark) cortin\* is secreted which, with the gonads, co-operates with the pituitary in regulating primary\* (reproductive) and secondary\* sex characteristics (body form, voice, beard, body hair). Oversecretion of cortin produces virilism\* in the female, as in the case of the bearded lady of the circus. Undersecretion of the adrenal cortex induces characteristic tissue changes as well as the behavior disorders found in Addison's\* disease.

The parathyroids\* are four tiny glands located adjacent to the thyroids and are believed to be depressant in their effects as contrasted with the excitant effects of the hormones\* secreted by the thyroid\* gland.

The islands\* of Langerhans are groups of glandular cells located in the pancreas. They secrete into the blood the hormone called insulin\*. This hormone keeps each cell of the body supplied with needed sugars and makes possible the storage of additional carbohydrates in the liver. With hypofunction of the islands *diabetes mellitus* develops. With overfunction *insulin shock* results. Diabetes may be controlled by the administration of insulin. Insulin shock is controlled by the injections of necessary sugars. It is to be noted at this point that insulin shock treatments are frequently used today in mental hospitals for the treatment of selected cases of schizophrenia\*. By injecting units of insulin, a coma is induced in the patient. Injections of sugars bring the patients out of the coma. Some authorities believe the insulin treatment is occasionally successful because it alters the chemistry of the brain cells, while others believe the treatment "shocks" the patient back to reality.

3. *Psychological*. Specific traits of personality are in the last analysis the result of both hereditary and environmental factors. Psychologically, however, man's characteristic ways of reacting are the by-products of learning by conditioning\*. It follows that the psychology of learning is also the psychology of personality development. For the development of well adjusted personalities a healthy environment from fertilization to death is essential.



### THE INTEGRATION\* OF TRAITS

If personality is defined as the sum of the reaction tendencies or generalized habits exhibited by an individual, integration or co-ordination of these characteristics is logically expected. Habits come to predispose man to respond in definite ways. With increase in the number of stimulating situations inducing any one characteristic habitual response, other already established reaction tendencies are brought into play. Integration means, therefore, that these tendencies are co-ordinated in the elicitation of a response. It means that the person, as a total organism, behaves with relative consistency from day to day.

Inasmuch as traits undoubtedly undergo modification throughout life, complete integration is not anticipated. Because people show different degrees of co-ordination between traits which they possess in varying amounts, they develop as compared with one another, a uniqueness called *individuality*. People differ, consequently, in the degree to which the habitual reactions composing the personality are correlated\*. Complete consistency is not expected because of (1) an ever-changing environment and (2) a continuous process of human adjustment necessitated by these environmental changes. The relatively well integrated personality is one who adjusts to his environment in socially and personally satisfying ways.

### EDUCABILITY OF PERSONALITY

Traits of personality, defined as characteristic ways of reacting and accounted for by learning of the conditioning type can be modified. Habits are learned and as such can be changed by learning. To accomplish this result, man must *first* desire (the role of motivation\* in human behavior has been discussed in Chapter VI) to alter a given generalized habit. *Second*, man must select a response which is both socially and personally satisfying for substitution. *Third*, he must practice this substitute response until the new reaction becomes partially automatic and habitual. Educability of personality is thus possible to the degree that hereditary and physiological factors permit environmental influences to alter man's reaction tendencies.

## TEST QUESTIONS

A. *True-False Statements.* Read each statement and decide as to its truth or falsity.

1. Personality, psychologically considered, is possessed by only a few people.
2. Only psychologists are active in the scientific study of personality.
3. A phlegmatic person is slow to anger.
4. Personality traits cannot be classed arbitrarily into types.
5. Most people to whom are administered introversion-extroversion scales earn scores at one extreme or the other.
6. Ambiverts are those who show highly introverted responses to statements on introversion-extroversion scales.
7. The leptosome is Kretschmer's description of the emotional reactions exhibited by the pyknic.
8. According to Kretschmer the schizoid person possesses an exaggerated degree of schizothyme traits.
9. When personality test scores earned by a random sampling of subjects are plotted, a bimodal distribution is yielded.
10. An eidetic image is an acute, photographic picture of a past experience or event.
11. Traits are symbolic of generalized habits.
12. Emotional sensitivity is a trait of personality.
13. Most people are either dominant or submissive in all situations.
14. Personality questionnaires were first developed during the period of the World War (1917-1918).
15. How personality and trait, as terms, are defined helps determine the nature of the lists of traits available for study.
16. The personality questionnaire is based upon data essentially introspective in nature.
17. Scores on psychological tests are always relative.
18. Self-rating scales are often less reliable than rating scales scored by a number of trained judges.
19. Character traits, when measured, are found to be highly inter-correlated.
20. Word associations by insane patients are less unusual than those of the normal group.

21. The ink-blot test makes use of the introspective method of observation.
22. Degree of masculinity-femininity cannot as yet be ascertained in the absence of psychological tests.
23. Any standardized psychological test must be reliable and valid.
24. To rely upon personality evaluations deduced from popular magazine articles is highly inadvisable.
25. The cretin suffers from an overactive parathyroid gland.
26. The cortex of the adrenal glands secretes adrenin.
27. Addison's disease is the result of an overactive adrenal medulla.
28. Insulin shock is sometimes used in the treatment of schizophrenia.
29. Personality traits cannot be modified.
30. The psychology of trait formation is the psychology of learning.
31. Individual differences in personality integration are partially accountable for individuality.
32. Personality traits are constants.
33. Generalization in behavior involves similar reactions to common elements in a number of stimulating situations.
34. Generalized adjustment mechanisms conform to the definition of a personality trait.
35. Some people are more stable emotionally than others.

B. *Completion Statements.* Read the incomplete statements and decide upon the words that would complete each statement.

1. The genesis of personality traits is most influenced by \_\_\_\_\_ . This factor was first emphasized by John \_\_\_\_\_ .
2. The first personality adjustment inventory was constructed by \_\_\_\_\_ in the year \_\_\_\_\_ .
3. Endocrinology is the study of the \_\_\_\_\_ glands.
4. The four most vital problems in the scientific study of personality are:
  - (a)
  - (b)
  - (c)
  - (d)

5. Spranger's classification of values implies that each adult subject might well possess one of the following six value characteristics:  
 (a) \_\_\_\_\_, (b) \_\_\_\_\_, (c) \_\_\_\_\_, (d) \_\_\_\_\_, (e) \_\_\_\_\_, and (f) \_\_\_\_\_.
6. The physico-chemical properties of protoplasm are:  
 (a) \_\_\_\_\_, (b) \_\_\_\_\_, (c) \_\_\_\_\_, (d) \_\_\_\_\_.
7. Maturation as a factor in personality development is defined as the \_\_\_\_\_.
8. The five personality variables agreed upon by Allport and Dashiell are (a) \_\_\_\_\_, (b) \_\_\_\_\_, (c) \_\_\_\_\_, (d) \_\_\_\_\_, and (e) \_\_\_\_\_.  
 . Dashiell adds a sixth called \_\_\_\_\_.
9. In the use of rating scales the "halo effect" can be counteracted by asking the judges to \_\_\_\_\_.
10. Hartshorne and May used the \_\_\_\_\_ method in their studies on traits in children.
11. The interview may be either \_\_\_\_\_ or \_\_\_\_\_ in type.
12. To determine the degree to which a person is emotionally mature the \_\_\_\_\_ scale could be used.
13. To determine the nature of a person's occupational interests the \_\_\_\_\_ schedule could be administered.
14. Hypothyroidism in the adult often results in a disease known as \_\_\_\_\_.
15. Three major factors determining the nature of personality traits are: (a) cultural; (b) \_\_\_\_\_; and (c) \_\_\_\_\_.

16. Hyperfunction of the anterior pituitary gland in the child and the adolescent, results in the condition called
17. Hypersecretion of the anterior pituitary in the adult induces a condition called
18. Three endocrine glands co-operating in the development of primary and secondary sex characteristics are: (a)  
; (b) ; (c)
19. The clinician and the mental hygienist define personality as
20. Adjustment mechanisms are habitual ways by which man resolves and overcomes

C. *Matching Test*. For each numbered item, select the name (in the first column) which is associated with the item.

- |                    |  |
|--------------------|--|
| ( ) Allport-Vernon | 1. Vocational interests are measurable.  |
| ( ) Bell           | 2. Emotional maturity can be measured.   |
| ( ) Hippocrates    | 3. Stories woven around a picture tell something about the personality.                      |
| ( ) Jaensch        | 4. People are held to be grouped in terms of their predominant values.                       |
| ( ) Jung           | 5. Studies of masculinity-femininity.  |
| ( ) Kretschmer     | 6. The measurement of man's values.  |
| ( ) Murray         | 7. One's adjustment to his home and his school can be measured.                              |
| ( ) Rorschach      | 8. The theory of the four temperaments.  |
| ( ) Spranger       | 9. <i>B</i> and <i>T-types</i> of eidetic imagery.   |
| ( ) Strong         | 10. The belief that people are either introverted or extroverted.                            |
| ( ) Terman         | 11. The Ink-Blot Test.   |
| ( ) Willoughby     | 12. The belief that physical builds are accompanied by characteristic traits of personality. |

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PART TWO

*Dictionary of Terms*

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## PART TWO

### Dictionary of Terms

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IN THIS section technical terms are listed and defined. Only those which are frequently met by the beginning student in introductory courses in psychology have been included. For the advanced student reference can be made either to Warren, *Dictionary of Psychology* (1934) or to English, *Students' Dictionary of Psychological Terms* (1933).

Note: Terms followed by an asterisk are defined or discussed in this dictionary section. Names followed by an asterisk are discussed in Part III.

**Ability:** Skill, or capacity\* to accomplish any task. See *aptitude, intelligence*.

**Abnormal psychology:** The scientific study of widely different (from the normal) forms of behaving.

**Abnormality:** In psychology, any very different form of behaving. See *normal, genius, insanity, feeble-mindedness*.

**Abreaction:** According to the psychoanalyst\*, abreaction consists in discharging one's emotions\* by recalling and telling the experiences which gave rise to the emotions.

**Abscissa:** The base line or x-axis of a chart, or curve.

**\*Absolute limen (threshold):** Minimal amount of physical energy necessary to stimulate a given sense organ 50% of the time. See *limen, threshold*.

**Absolute pitch:** The ability\* to recognize and name a specific tone\*. At one time absolute pitch was assumed to be inherited. Recent evidence indicates that training also contributes to this ability.

- Abstraction:** The process of recognizing the common aspects of a group of objects and treating this common quality as if it had a separate existence.
- Abulia (aboulia):** Abnormal condition marked by an inability to arrive at a decision. Sometimes a pathological\* condition.
- Accommodation:** Increase in curvature of the lens of the eye for clear vision of nearer objects. Decrease in curvature results in better vision for more distant objects. See *focus*.
- Accomplishment quotient:** Achievement\* age divided by the mental\* age. A ratio of achievement to ability, in years and months.
- Achievement:** Actual as distinguished from potential accomplishment. The term is most often used in reference to the mastery of school tasks. See *battery*, *intelligence test*.
- Achievement age:** The chronological\* age at which a particular score on an educational test is normally attained by the average\* student. See *norm*, *chronological age*, *mental age*, *educational age*.
- Achievement quotient:** Achievement\* age divided by the chronological\* age.
- Achievement test:** A test which measures accomplishment in a field of subject matter or skill.
- Achromatic:** Absence of color, as in the black-gray-white series.
- Acromegaly:** Disease characterized by continued growth of the fingers, hands, feet, and face as a consequence of hyperfunction\* of the anterior lobe of the pituitary\* gland in the adult.
- Acrophobia:** Morbid fear\* of being on high elevations. See *phobias*, *agoraphobia*.
- Action current:** Changes in electric potential in nerve\* and muscle tissue generate very weak electric currents. These weak currents, measured by a sensitive galvanometer\*, are called action currents.
- Action potential:** Waves of change in electrical potential which accompany conduction in nerves\* and contraction in muscle tissue.
- Addison's disease:** Disease due to hypofunction\* of the adrenal\* cortex\*.
- Adequate stimulus:** Any physical energy which is ordinarily appropriate for the excitation\* of a specific receptor\*, e.g., light waves on the retina\*.

- Adjustment mechanism:** The acquired habits whereby man overcomes frustrations and conflicts, in his efforts to reach goals and gain satisfactions. Typical adjustment mechanisms are those of attack, defense, escape, and surrender. See *aus-dem-felde-gehen*, *conflict*, *escape mechanism*, *defense mechanism*.
- Adjustor:** The neurone\* which connects the sensory and motor parts of the sensorimotor\* arc. Syn., connector\*.
- Adolescence:** The age period in which the sex organs and reproductive functions are maturing most rapidly. The period between childhood\* and maturity\*, beginning frequently at about the age of eleven among girls and thirteen among boys. The age period, however, varies considerably in individual cases and in different parts of the world. See *puberty*.
- Adrenal glands:** Paired endocrine\* glands located near the kidneys. The core, or medulla\*, secretes adrenin\*, and the bark, or cortex\*, secretes cortin\* into the bloodstream. See *ductless glands*, *adrenin*.
- Adrenin:** Complex chemical substance secreted as a hormone\* into the bloodstream by the adrenal\* gland (medulla portion). Syn., epinephrin.
- Affection:** A general term which includes all the feeling\* qualities of experience: emotion\*, mood\*, pleasantness and unpleasantness, sentiments\*, attitudes\* and interests\*. See *impression method*.
- Afferent:** Leading to. Refers particularly to nerve\* fibers leading to the brain\*, as, for example, in the case of sensory neurones\*. See *efferent*.
- After-discharge.** A characteristic of a nerve\* fiber or of a nerve center to continue to transmit impulses after removal of the stimulus\*.
- After-image:** After an external stimulus\* has ceased to excite, sensory experiences may persist or reappear. These are after-images. If they are like the original they are *positive*. In color vision, if they are the opposite of the original sense experience, they are called *negative* after-images.
- Age-scale:** A psychological test of any kind for which scores are available in terms of developmental months. These values are based upon what average\* children at various ages can do on the test. See *point scale*, *norm*.
- Agoraphobia:** Fear\* of open places. See *phobias*, *claustrophobia*.



**Agraphia:** Complete or partial inability to write, resulting from disorders of the cerebrum\*. See *alexia*.

**Alalia:** Lack of ability to speak, resulting from defect in the vocal cords. See *aphasia*, *agraphia*.

**Alcohol:** An intoxicating fluid that reduces the efficiency of learning in proportion to the amount ingested by the subject. A depressant drug. See *Korsakoff's psychosis*.

**Alcoholic psychoses:** A general term including all the psychotic\* reactions resulting from prolonged alcoholic indulgence. See *alcohol*.

**Alexia:** Inability, because of brain defect, to understand written messages. See *agraphia*.

**All-or-none law:** The principle which states that the strength of the response evoked by any stimulus\* applied to a single nerve\* or muscle fiber is maximal or nothing. The intensity of the stimulus does not determine the magnitude of the response.

**Alpha examination:** A battery of group\* intelligence\* tests developed for testing World War (1917-1918) recruits in the United States. See *Beta examination*.

**Alpha hypothesis:** A theory formulated by Knight Dunlap which states that the occurrence of one response increases the probability that repetition of the same stimulus\* will lead to repetition of the same response. See *exercise*, *law of*.

**Alpha wave:** Brain wave discovered and described by Berger\*. Its frequency is roughly ten per second.

**Altruism:** Concern for the welfare of others.

**Ambiguous figure:** A sensory pattern which when perceived may be interpreted in two or more ways.

**Ambiguous perspective:** The alternation between interpretations by an observer while he is attending to a figure that is ambiguous with reference to concavity or convexity.

**Ambivalence:** Opposing affective states directed toward the same person or object at the same time, e.g., love and hate.

**Ambivert:** A person possessing balanced introverted\* and extroverted\* traits\* of personality\*. See *extroversion*.

**Amblystoma:** A kind of salamander used by Coghill and others in studies on growth\* and maturation\* during embryonic life.

**Amentia:** Medical term for any degree of feeble-mindedness\* present at or shortly after birth. See *idiot*, *imbecile*, *moron*.

**Amnesia:** Partial or complete inability to recall\*, caused by functional\* or organic factors\*.

**Ampulla:** The enlarged ends of the semi-circular\* canals, which contain receptor\* cells that can be stimulated by movements of the head and body.

**Anabolism:** A general term which refers to the whole process of building structures within the organism. See *metabolism*.

**Anaesthesia:** Partial or complete loss of sensitivity to stimuli\*.

**Analgesia:** Loss of ability to experience sensations\* of pain.

**Analysis:** (1) Psychoanalytic—the method devised by Freud\* for the discovery of the nature of repressed\* memories\*; (2) auditory—the central problem in auditory theory, viz., how the hearing mechanisms analyze complex tones\* into their components.

**Anecdotal method:** The narration of selected stories which one presents as evidence in support of a conclusion. The reliability of this method is questionable.

**Animal psychology:** The scientific study of the behavior\* of animals.

**Animism:** A once current belief that animate and inanimate objects were inhabited by spirits which directed their movements.

**Annoyer:** Any stimulus\* which initiates a feeling\* of unpleasantness. See *effect, law of*.

**Anosmia:** Inability to smell.

**Anterior:** In front of. See *posterior*.

**Anthropology:** Scientific study of the origin of man and of the distribution of races and peoples.

**Anthropomorphism:** The imputing of human characteristics to a deity, to lower animals, or to inanimate objects.

**Antidromic conduction:** The process whereby electrical stimulation of a single isolated neurone\* causes a nerve\* impulse to flow in a direction other than the usual one-way path of a neural impulse. See *polarity, principle of*.

**Anxiety:** A generalized vague fear of the future. A subacute form of fear alternating with hope for the future. See *phobia, worry, hypochondriac*.

**Apathy:** Indifference.

**Apraxia:** Complete or partial loss, as a result of defective brain function, of ability to speak and to understand words.

**Aphasia:** A speech defect which prevents the individual from expressing himself in complete phrases or sentences. See *alalia*.

**Apparatus:** Any instrument used in any scientific experiment\*.

**Apparent movement:** Perception of motion when no motion is physically present. In the *Phi\** *Phenomenon* if line 1 and line 2 are presented with a short interval between the presentations, line 1 will be seen to move to line 2.

**Apperceptive mass:** A term used by Herbart\* to designate the nature of a pupil's information prior to new learnings. Teaching should build upon this mass of information already accumulated by the pupil.

**Appetite:** A general term meaning desire for a specific object, experience, or satisfaction.

**Applied psychology:** A branch of psychology\* concerned with the application of principles rather than with their theoretical implications. Educational psychology and industrial psychology are illustrations. Applied psychology is psychology in use.

**Apprehension:** The activity of becoming aware of that which is present to the sense\* organs.

**Apraxia:** The inability to manipulate objects, due to brain defect.

**Aptitude:** A special ability\* for the acquisition of certain response patterns, such as skill in music and art.

**Aptitude test:** A standardized\* experiment for the measurement of special abilities\*.

**Argyll-Robertson pupil:** The pupil of the eye is so called when it fails to contract with changes in light intensity. Present in locomotor\* ataxia.

**Arithmetic mean:** A measure of central tendency, that is, an average, found by adding a series of measures and dividing the sum by the number of cases. See *median*, *mode*.

**Ascendancy:** The habit of taking responsibility when an emergency arises. The practice of self-assertion by assumption of the leadership role. See *extroversion*, *submission*.

**Assimilation:** The principle which states that man reacts to new situations very much as he reacts to familiar ones. Similar and identical\* elements in the new experiences, as compared with the old, are held accountable.

**Association (associationism):** The formation of connections or bonds

between items of experience. The term was early applied to signify connections between ideas\* and memories\*. More recently, it has been held that the conditioned\* response is an objective statement of the older concept of association.

**Association test:** A test consisting of stimulus-words to which the subjects\* react by reporting the first word that occurs to them. This test is used to detect guilt and to help discover the nature of the "complex."\* Reaction\* times are recorded for each verbal response.

**Associative inhibition\*:** Increased difficulty in learning by association\*, due to interference by earlier associative connections.

**Associative learning\*:** Formation of new connections between ideas\*, words, events, or other stimuli\* and responses.

**Associative shifting:** The theory that every reaction\* to a stimulus\* can be associated with any other stimuli that affect an individual. See *conditioned response*, *conditioning*.

**Asthenia:** The general loss of physical vitality and energy. See *neurasthenia*, *hyperkinesis*.

**Asthenic:** A lean, slender undeveloped type of individual, according to a classification by Kretschmer\*.

**Astigmatism:** A visual defect caused by failure of the light rays reflected from an object to come to a focus on the retina\*. The maladjustment is due to a difference of curvature of the cornea\* in the horizontal and vertical axes.

**Ataxia:** Loss of ability to co-ordinate voluntary\* movements. See *apraxia*.

**Athletic:** A muscular, well built type of individual, according to Kretschmer's\* classification.

**Atomism:** The belief that any totality, such as the human organism, can be explained in terms of its parts.

**Attention:** Preliminary act of adjustment whereby the act of perception\* is facilitated. Experientially defined, attention refers to the clearness in consciousness\* of sensory or imaginal states. Certain authors differentiate between *involuntary* (effortless and unlearned attentive adjustment), *voluntary* (effortful attention), and *non-voluntary* (effortless and acquired ways of attending).

**Attitude:** Specific mental set\* or disposition to react in particular ways toward issues which arise. Man's attitude or predisposition to

react in a pacifistic or militaristic way toward war is illustrative. See *belief*.

**Attitude scale:** A standardized\* scale for measuring man's predispositions toward an issue or question, such as war, religion, the law.

**Attributes:** Basic, elemental characteristics of man's experiences. The attributes of quality, intensity, duration, and extensity have been frequently used to describe man's conscious\* experiences.

**Audiogram:** A chart showing how acutely man hears.

**Audiometer:** An instrument used to measure the auditory acuity of man.

**Audition:** Sense of hearing.

**Aufgabe:** Task; problem; the instruction.

**Aus-dem-felde-gehen-response:** An escape\* mechanism in which the individual runs away symbolically from a difficulty by thinking about or doing something else in the same vicinity as the barrier. Described and so designated by Kurt Lewin\*. See *adjustment mechanism*.

**Aussage Test:** Narrative reports by observers, used to study the reliability of testimony in observation experiments.

**Autistic thinking:** Wishful thinking.

**Autokinetic action:** Movements initiated by proprioceptive\* stimuli within the muscles of the body.

**Autonomic nervous system:** The efferent\* division of the nervous\* system which supplies the glands\* and smooth\* muscles of the body with neural\* fibers. These connecting neurones\* arise from either the brain\* stem or the spinal\* cord. The autonomic system is divided into two functional divisions, the *sympathetic* and the *parasympathetic*. The sympathetic\* portion is functional during strong emotions and other stirred up conditions of the organism. The parasympathetic\* functions under all other conditions. See *cerebrospinal system*, the second major division of the nervous system.

**Average:** A typical value which sums up or describes a mass of data collected. It is a measure of the location of central\* tendency. Three well-known kinds of averages are called *arithmetic\* mean*, *median\**, and *mode\**.

**Average deviation\* (A. D.):** A measure of scatter\* or dispersion taken from the arithmetic\* mean of the scores collected.



**Axone (axon):** The long fibrous extension of a neurone\*. This extension carries the nerve excitation\* from the cell body toward the synapse\* and dendrites\* of another neurone.

**Axone cylinder:** The central core, or fiber portion of the axone\*.

**Babinski sign:** Stimulation of the sole of the foot elicits extension of the toes. A clinical sign indicative of a pathological\* condition in the cerebrospinal\* segments of the nervous\* system when observed in individuals beyond the period of infancy\*.

**Basal age:** That mental\* age level at which all items of an intelligence\* test (age-scale type) are passed. If a child passes all items at the 8-year level and some of the 9-year tests, his basal age is 8 years. See *I. Q.*

**Basal ganglia:** Nerve centers composing part of the gray\* matter in the lower part of the cerebrum\*.

**Basilar membrane:** Fibrous membrane which divides the cochlea\* into two compartments, the *scalae tympani* and *vestibuli*. This membrane has been assumed by Helmholtz\* to function in the peripheral\* analysis of complex sounds by means of sympathetic resonance.

**Battery:** A series of specific tests combined into a unit examination, such as the Army Beta\* which is composed of eight different parts. A series of separate tests in various subjects, given together so as to yield a total score indicating achievement.

**Beat:** Alternation in intensity of two tones\* differing in their frequencies\*.

**Behavior:** A general term including all observable responses of an organism.

**Behavior pattern:** A group of several related responses, such as those involved in repeating the alphabet.

**Behavior sampling:** Observed reactions of a subject which are taken as indications of personality traits\* or of typical methods of response to stimuli.

**Behaviorism:** A modern school of psychological thought which has emphasized the need for objective\* study of muscular and glandular reactions without reference to conscious\* experience. John Watson\*, its founder, in 1913 suggested this approach and did much to

develop it by means of his classic studies in child and animal behavior. This approach, with its emphasis upon objective observation, is to be distinguished clearly from the Structuralist's\* emphasis upon the method of subjective observation, or introspection\*.

**Belief:** Acceptance of a statement because of accumulated evidence held to be adequate.

**Bell Adjustment Inventory:** A scale devised in 1934 for measuring the degree of maladjustment among high school and college students in relation to home, health, and social and emotional conditions.

**Bell-shaped curve:** A curve which shows graphically a normal\* distribution of data. The number of cases increases as both ends of the curve approach its center. Also called *Gaussian curve*, *normal curve*, *normal\* distribution curve*.

**Bell's Law:** The principle, established in 1811, that in the spinal nerves, which comprise both sensory and motor elements, each part is connected with or related to a different specific region of the spinal cord.

**Belongingness:** Thorndike's\* principle of associative learning, which states that new associations\* are assimilated by a process of connecting them with familiar ones to which they bear a resemblance.

**Beta examination:** A battery of non-verbal intelligence\* tests devised for testing groups of World War recruits (1914-18). The items are presented by means of signs and pantomime. The test is used for testing illiterates\* and non-English speaking adults. See *Alpha examination*.

**Beta hypothesis:** The hypothesis\* which holds that certain undesirable habits\*, such as errors in typing, may be eliminated by practicing them. Studied by Knight Dunlap.

**Beta waves:** Waves of electrical variations recorded from the brain of human subjects. Although the beta waves are smaller in magnitude than the alpha\*, they are, nevertheless, faster as shown by their frequency of 25 per second. See *electroencephalograms*.

**Bimodal:** Two peaks or modes\* in a frequency\* distribution\* of scores. The bimodal curve is never obtained in psychology with a random\* sampling of subjects and with a properly standardized\* test. See *multi-modal curve*.

**Binaural:** Referring to hearing by means of the joint action of the two ears.

**Binet-Simon test:** The intelligence\* test devised by Binet\* and Simon in 1905. The stage of mental development of a child was calculated in terms of credit (in developmental months) given for each item passed. This first test has been revised and extended several times. See *achievement test*.

**Binocular:** (1) Vision\*—sight by means of the joint action of the two eyes; (2) parallax—apparent displacement in space of an object as seen from slightly different points by the two eyes. This difference in the retinal images is one factor which makes possible the perception\* of visual depth. See *corresponding points*, *convergence*, *focus*, *strabismus*.

**Blend:** A fusion of elements which compose an experience, such as in the awareness of moisture.

**Blindness:** Visual deficiency compelling an individual to use his other senses, either largely (partial blindness) or exclusively (total blindness) for orientation to his environment.

**Blind spot:** A small area on the retina\* containing no rod\* or cone\* cells. The area of exit of the optic nerve\*. It is insensitive to light stimulation.

**Block (mental block):** When a stimulus-word, in an association test, elicits no verbal response, the subject is said to have a mental block or lack of ability to make or express associations with the stimulus-word.

**Bond:** A psychological concept\* designating, for Thorndike\*, an assumed connection of unknown nature between neural elements which mediate associations\*.

**Bone conduction:** The process whereby sound waves are conducted to the inner ear by stimulation of the bones of the head and jaw.

**Brain:** The neural tissue contained within the skull. The brain includes the cerebrum\*, cerebellum\*, corpus callosum\*, thalamus\*, and medulla oblongata. There are two hemispheres connected by the corpus callosum. The outer layer of the brain is the cerebral cortex\*, a most important structure in the higher processes of brain functioning.

**Brain stem:** That portion of the brain\* below the cerebrum\* and the basal\* ganglia.

**Brain waves:** Changes in electrical potential in the cerebral\* cortex\* generate very weak electric currents which can be measured in terms of their frequency, duration, and amplitude. These oscillations are called brain waves. Recordings of these waves are known as electroencephalograms\*.

**Brightness:** Intensity of a light reflected from a surface. Measured by a photometer.

**Broca's convolution:** That small portion of the left cerebral\* hemisphere in a right-handed person found essential by Broca (1861) for speech. Broca's speech area.

**B-type:** Children of a type who can recall easily and at will their photographically clear eidetic\* images. The term was used by Jaensch\* in 1930.

**By-product method:** A method of studying the culture of any historical period by analysis of the writings of famous people who lived during that period. Closely related to anthropology\*.

**C. A.:** See *chronological age*.

**Calcarine cortex:** The visual cortex\*.

**Callosum, corpus:** Thick bands of nerve\* fibers which connect the two cerebral\* hemispheres. See *brain*.

**Canon:** A rule of thumb which is useful in arriving at scientific truths. Morgan's\* canon is an illustration.

**Capacity:** Potentiality for use. Refers to one's capability in terms of native constitution. See *intelligence*.

**Case history:** The method often used to collect all pertinent material about a person in order to understand his present behavior in the light of his past experience. A clinical rather than an experimental approach.

**Catabolism (katabolism):** A general term to designate the breaking down of living tissues. See *metabolism, anabolism*.

**Catalepsy:** A condition in which limbs when placed in given positions will remain in such positions. Characteristic of abnormal\* states.

**Category:** A class or group of items or elements.

**Catharsis:** The psychoanalytic\* method of talking out one's troubles. See *Freud*.

**Cathode ray oscillograph:** An instrument for detecting and photo-

graphing faint electric waves as brain waves or vowel sounds on a microphone.

**Caudal:** Toward the tail.

**Cell-body:** The central portion of the nerve\* cell. The dendrites\* and the axones\* compose the remainder of the nerve cell.

**Cell theory:** The theory that all organs are made up of cells. Theory formulated by numerous workers including Hooke (1665), and Schleiden and Schwann (1838).

**Censor:** That agent, assumed by the psychoanalysts\*, which prevents the entrance of unpleasant memories\* into consciousness\*.

**Center, cortical:** Cluster of nerve\* cells in the cortex known to mediate a specific function.

**Centile rank\*:** A statistical value designating one's position along the base-line of the normal\* distribution curve. A centile rank\* of 10 means that one's score is better than 10 per cent of the group tested. *Decile\** means that the curve is divided into 10 equal parts, while *percentile\** means the curve is divided into 100 divisions. A percentile\* rank of 80 means that one's score is higher than 80 per cent of the group tested.

**Central nervous\* system:** The brain\* and the spinal\* cord without the cranial\* and peripheral\* nerves.

**Central tendency:** Refers to measures of the clustering of scores around the middle. The measures are the mean\*, median\*, and mode\*. See *average, distribution, deviation*.

**Cephalic:** Head end. Pertaining to the head. See *cephalic index*.

**Cephalic\* index:** A measurement of the head, found by dividing the width by the length of the skull and multiplying the quotient by 100.

**Cerebellum:** That neural structure, located close to the pons\* and medulla\*, which functions in muscular co-ordination.

**Cerebral:** Pertaining to the cerebrum\*.

**Cerebral dominance:** One hemisphere is dominant or ascendant over the other. The left hemisphere in right-handed persons is dominant over the right.

**Cerebrospinal system:** The portion of the nervous\* system which includes the brain\*, spinal\* cord, and the peripheral\* nerves. See *autonomic nervous system*.



**Character:** The social and ethical aspects of personality\*.

**Characteristic:** A distinguishing attribute\* or aspect.

**Chiasm:** A bridge. The optic chiasma is that region at which the optic nerves from the eyes meet and later diverge on their ways to the visual cortex\*.

**Childhood:** The age period between infancy\* and adolescence\*. The duration of this period is most frequently about fourteen years, but varies among individuals and regions. See *puberty*, *maturity*, *cretin*.

**Chorea:** Irregular motor reactions due to pathological\* conditions of central motor centers. St. Vitus' Dance.

**Choroid coat:** Middle coat of the eyeball.

**Chromatic:** That which has color.

**Chromosomes:** Bearers of hereditary characteristics by means of the genes\*. The genes, strung out as pairs in the chromosomes, are believed to transmit qualities from parents to children.

**Chronaxie:** A number-index which expresses the excitability of muscle and nerve tissues. This number is in terms of the time required by a constant electric current (double the minimal value) to excite\* a specific tissue. The chronaxie is used as a clinical indicator of pathological\* conditions in nerves\* and muscles. The French physiologist, Lapicque, was the first to observe and to measure accurately this relation between the strength of a stimulus\*, its duration, and the response.

**Chronological age (C. A.):** One's age in years, months, and days. See *achievement age*, *mental age*.

**Ciliary muscle:** The smooth\* muscle which controls the curvature of the lens of the eye.

**Ciliary processes:** Connective tissue about the lens of the eye attached to the ciliary\* muscle.

**Clairvoyance:** The hypothesis\* that man can know the past, present, and future by foreseeing without the necessity of using the eyes or direct sense experience. See *telepathy*.

**Classification test:** A test wherein the pupil is required to indicate the group of items to which a particular item belongs.

**Claustrophobia:** Exaggerated fear\* of being in closed places. See *agoraphobia*, *acrophobia*, *phobias*.

**Climacteric:** The menopause, or "change of life."

**Clinic:** An agency for the study, diagnosis\*, and treatment of physical and mental disorders.

**Closure:** The principle whereby man's actions, perceptions, and memories become a "closed" pattern or totality. In problem-solving the solution and the problem become united or closed into a total pattern. A Gestalt\* term.

**Cochlea:** Spiral structure situated in the inner ear. Contains the receptor\* cells for hearing.

**Coefficient of correlation:** A number ranging from  $-1.0$  to  $+1.0$  and expressing the degree of relationship between two or more variables. Its symbol is  $r$ .

**Cognition:** A general term which includes the activities by which man comes to accumulate knowledge. Knowing.

**Cold spot:** Point on the surface of the body sensitive to temperatures lower than those of the body.

**Color-blindness:** Usually an inherited sex-linked defect in color vision, indicated by the decrease in the number of hues discernible. May be complete or partial. Occasionally, acquired color-blindness results from an organic defect in the visual system. See *deutanopia*.

**Color mixer:** An instrument for mixing different colored lights upon the same retinal areas.

**Column:** A nerve\* tract or bundle, ascending or descending in direction.

**Commissure:** Nerve\* tracts which connect one brain\* or spinal\* cord region with the corresponding area on the other side.

**Compensation:** A way of adjusting to conflicts in order to make up for one's deficiencies by emphasizing desirable aspects of one's behavior. *Over-compensation* implies an over-emphasis of this sort.

**Complementary colors:** Any two colors which when mixed result in sensations of gray.

**Complex:** A group of emotionally toned ideas\*. May be normal\* or abnormal\* in nature. Complexes occasionally met are those designated as sexual, fear\*, inferiority\*, superiority\*, in nature. See *association test*.

**Complex indicators:** Evidence (disclosed by the rate or character of an

individual's responses, or by his failure to respond to a stimulus-word) of the existence, content, and strength of a complex.

**Complication experiment\*:** In studies of man's reactions to simultaneous stimulations, this classical experiment shows that the subject may see first either of the stimulating conditions. There is, therefore, an advantage in providing instructions to establish a mental set\* and thereby determine the *prior entry* of certain elements into conscious experience.

**Comprehension:** Knowledge about, understanding.

**Compulsion:** The irresistible performance of an act known to be unnecessary and senseless.

**Conation:** A general term designating the activities of desiring or willing.

**Concentration:** The point of final concentration of an irradiated wave impulse.

**Concept:** When formulated in words, the concept is a term which refers to several events or objects previously experienced. The concept of honesty is illustrative. See *percept*, *idea*.

**Conditioned response:** A response aroused by a stimulus\* which, prior to learning\*, did not elicit the same reaction. A substitute response.

**Conditioned stimulus:** That inadequate stimulus\* which, after repetition with an adequate stimulus, comes to elicit the response associated with the adequate stimulus. See *unconditioned stimulus*.

**Conditioning:** The process whereby associations\* established between two stimuli cause a response previously elicited by one of the stimuli to be elicited also by the second stimulus\*.

**Cones:** Cells, cone-like in shape, located on the retina\* of the eye. They, along with the rods\*, are the receptors\* in vision\*.

**Configuration:** A Gestalt\* term indicating that parts of any perceptual pattern do not equal the whole, since each part influences every other. The whole pattern, the configuration, is more than the sum of its parts.

**Conflict:** A stimulating situation to different aspects of which man is motivated\* to make different responses, each antagonistic to the other. See *adjustment mechanism*.

**Confluence:** Apparent flowing together; confusion. In perception, confluence results in an illusion of size differences.

**Congenital:** A factor present at birth though not necessarily inherited in its entirety.

**Conjugate movements:** Co-ordinated action of the two eyes, for the fixation of objects in space.

**Connectors:** Neural fibers that conduct nerve impulses from receptor\* organs to muscles and glands\*. See *adjustor*.

**Conscious:** According to Freud\*, the mental experiences of which we are aware or about which we think.

**Consciousness:** Awareness.

**Consonance:** A tonal blend judged as smooth, harmonious, and often pleasant.

**Constancy:** The principle that an object maintains its standard or real character despite changing conditions of perception\*. Thus, an object is known to have its usual size and form, regardless of its distance from the observer or of changes in perspective.

**Constant error:** Displacement of experimental data from an accepted and known standard, as a consequence of the influence of a constant factor operating throughout the experiment\*.

**Constant stimulus method:** A way of determining man's ability to sense and to discriminate between stimuli\*. Developed as a technique in psychophysics\* by Fechner\*.

**Contiguity:** Occurring together in time and space.

**Contiguity, law of:** The principle that if two or more events occur together in time and space, the later presentation of one will reinstate the other. See *association*, *similarity association*, *succession*, *contrast*.

**Continuity:** A Gestalt\* law of perception\* which states that objects or stimuli that can be combined readily to form a more complex figure are perceived as unitary entities. Thus, dots that can be put together to form a line are seen to be a single figure.

**Contour:** The outline or boundary of a figure.

**Contractility:** A basic protoplasmic property by which living tissue draws together when stimulated.

**Contrast:** (1) Visual—Two or more colors when placed close together often induce exaggerated sensations of their differences; (2) binocular—the two eyes when stimulated by different colors may

induce sensations of visual contrast; (3) associative—Aristotle's principle that one item tends to recall the opposite (light-dark).

**Contrasts, method of:** A method in which the capacity to discriminate can be tested by presenting stimuli that are progressively more like an original adequate\* stimulus.

**Control experiment\*:** An investigation used as a check for possible uncontrolled variables\* in previously conducted studies. Inasmuch as no experiment may have more than a single independent\* variable it is occasionally necessary to check the accuracy of one's finding by running control studies of other factors which may also have varied somewhat.

**Control group:** In a scientific experiment\* the control group is the group not affected by factors which are being studied. The experimental\* group is subjected to such factors and, being otherwise very similar to the control group, makes it possible to analyze the effects of the experimental factors. See *scientific method*.

**Convergence:** (1) Visual—The two eyes turn toward the object and each other, so that the retinal images are identical or very similar; (2) neural—the coming together of nerve excitations, or disturbances, into a single nerve unit. See *binocular*, *corresponding points*, *diplopia*.

**Convolution:** The rounded surface of the brain between fissures\* or sulci.

**Convulsion:** Marked contractions of many muscles by virtue of central nervous action. Present in epilepsy.

**Cornea:** External and transparent portion of the sclerotic coat of the eyeball.

**Corneal reflex:** Eyelid reflex upon pressure stimulation of the cornea.

**Corpus callosum:** See *callosum corpus*.

**Correlation center:** A neural region into which neural disturbances converge and bring about their unified influence on behavior.

**Correlation (method of):** A statistical method by which the degree of relationship among variables\* can be calculated.

**Corresponding points:** Points on the retina\* that are similarly placed thereon, so that both eyes can see a single object. See *binocular*.

**Cortex:** Outer layers of any organ, e.g., of the cerebrum\*, cerebellum\*, adrenal\* gland.



- Corti, organ of:** A structure within the internal ear of mammals which contains the nerve\* fibers necessary for initiating hearing.
- Cortical:** Pertaining to the cortex\*.
- Cortical point:** A small area of the brain cortex\* possessing a specific function. Observable by means of electrical stimulation.
- Cortin:** A secretion of the cortex of the adrenal glands. These glands and the gonads co-operate with the pituitary (hypophysis) in regulating primary and secondary sex characteristics.
- Co-twin control:** Same as training\* method.
- Covert:** Hidden, not obvious. See *overt*.
- Cranial nerves:** The nerves\* arising from the upper brain\* stem, which connect sense organs with muscles and glands\*.
- Cranial-sacral reactions:** The reactions of the parasympathetic\* parts of the autonomic\* nervous system.
- Cretin:** An individual, who, since early childhood\*, exhibits mental and physical retardation due to the underfunctioning of the thyroid\* gland. See *giantism*, *hyperthyroid*, *hypothyroid*, *feeble-mindedness*.
- Criterion:** Standard, a test for truth.
- Cross-education:** Training in which the use of one member of the body aids in the use of an untrained member.
- Cue:** In an experiment, a weak secondary stimulus\* which guides the behavior of the subject. Control\* experiments are conducted to test for the presence of the uncontrolled factors. See *reduced cue*.
- Culture:** Characteristic status of the accomplishments of an individual or group.
- Cumulative frequency\*:** The total sum of cases from the beginning of a series of scores up to any given point in the distribution\*.
- Curare:** A drug inducing paralysis of motor nerve endings.
- Curve of learning:** See *learning curve*.
- Cutaneous sensation:** Unless specified, any sensation\* from the skin.
- Cutaneous senses:** Those senses for which receptor\* cells are located in the skin. The cutaneous senses include pressure, warmth, cold, and pain senses.
- Cycloid:** See *cyclothyme*.
- Cyclothyme:** Kretschmer's\* characterization of a normal\* personality\* type. The *pykniċ*\* individual in society was held to be of sunny disposition with occasional tendencies toward gloominess. The

*cycloid* personality represents an exaggeration of these personality traits, observed most clearly in cases of manic\*-depressive psychoses.

**Dark adaptation:** The increased sensitivity of the eye to light.

**Day dreaming:** Reverie in which one imagines many desired events.

See *phantasy*.

**Deafness:** Complete or partial lack of ability to hear. There are widely varying degrees of deafness. Caused by defects in the ear or in the nervous system. See *hypacusis*.

**Decerebrate:** An animal deprived of its cerebrum\* is called a decerebrate animal or specimen.

**Decibel:** The unit of intensity of a sound.

**Deciles:** Those values in a distribution which divide the scores into groups of ten.

**Decorticate:** An animal surgically deprived of the brain cortex\* is said to be a decorticate animal.

**Decussation:** The crossing of nerve tracts from left to right (or right to left) in their course to or from higher centers in the brain\*.

**Deduction:** Reasoning\* from the general to the specific. Induction\* is reasoning from the specific to the general.

**Defense mechanism:** Self-protective reaction whereby one avoids scrutiny of the reason for one's behavior. The individual justifies his actions to himself and to others by formulating reasons and excuses for what he did. See *adjustment mechanism, rationalization*.

**Déjà vu:** An illusion of recognition\* in which the subject believes he has already experienced what is in reality a completely new situation. See *memory image, paramnesia*.

**Delayed reaction:** A response made after an interval succeeding the removal of the stimulus\*. Such a reaction is held to be dependent upon ideational\* activities, and for this reason is often used to study these processes.

**Delayed reflex\*:** A conditioned\* response which is delayed for a period of time equal to the interval between the conditioned\* and unconditioned\* stimuli.

**Delta waves:** The slowest type of brain waves, with a frequency of from three to six per second. The presence of delta waves is diagnostic of pathological conditions in the cerebrum. See *alpha waves, beta waves*.

**Delusion:** A morbid false belief\*, unchangeable despite appeal to reason. Observed in cases of insanity\*. See *fixed ideas, illusion, hallucination*.

**Dementia:** Deterioration of mind as observed in paresis\* and other abnormal\* states. See *insanity*.

**Dementia praecox:** A group of psychotic\* reactions studied and classified by Emil Kraepelin. So named because of the assumption that the disorder is a deterioration that occurs primarily among those between the ages of 15 and 30. See *schizophrenia*.

**Dendrite:** The bushy terminals of the neurone's\* cell-body\* which transmit the impulses to the cell-body and toward the axone\*.

**Dependent variable:** Comprises the subject's responses to the independent variable, or to the experimentally varied factor. In certain conditioning experiments lifting of the foot by the experimental animal in response to audible frequencies is the dependent variable.

**Depression:** A pathological condition characterized by feelings of grief, morbidity, and inadequacy.

**Depth perception\*:** An observer's appreciation of the distance between him and objects. Most used for vision.

**Derived motives (secondary motives):** Behavior drives\* which, through the learning\* process, have become associated with new means of attaining satisfaction. Illustrations are the motives to gain social approval, to conform, to be secure, etc.

**Determinism:** The assumption in scientific methodology which holds that all phenomena are the results of antecedent causes. The problem for the scientist is, therefore, to discover and isolate these causes in order to understand, predict, and control. Its opposite is the assumption that there are causal factors which cannot be discovered and isolated—*indeterminism*.

**Deutanopia:** A type of partial color-blindness\* in which the green is perceived as darker than the red. Related to green blindness. See *dichromatism*.

**Development:** A general term signifying structural changes which occur from conception to maturity\*.

**Deviation:** Variation from the average\* (central\* tendency). See *average deviation, standard deviation*.

**Dextrality:** Right-handedness.

- Diagnosis:** Inquiry to discover abilities, characteristics, or needs of individuals. A *diagnostic test* is a test which discloses the specific accomplishments and deficiencies of the pupil. On the basis of such disclosures, follow-up work can be assigned to meet his needs. See *prognostic test*.
- Diagnostic test:** See *diagnosis*.
- Diathesis:** Inherited predisposition toward the development of certain behavior\* patterns. The term also includes the contributory role of the environment in the induction of these reactions.
- Dichotomy:** Two classes or groups which differ in known or assumed respects.
- Dichromatism:** Partial color-blindness\*. The subject sees only two primary colors, usually the blues and the greens, according to Helmholtz. See *deuteranopia*.
- Difference limen\*:** The amount two stimuli\* must differ in order to be perceived as just noticeably different in 75 out of 100 presentations.
- Difference tone\*:** The third tone heard when two tones are sounded together. Its frequency is equal to the difference between the frequencies of the two sounding tones. See *overtones*.
- Differential psychology:** See *individual differences*.
- Diffusion, principle of:** The principle that because all organs are connected by nerves with the central\* nervous system, impulses in every sensitive cell may be transmitted to any muscular or glandular response mechanism.
- Dioppter:** Unit of measurement designating the power of convergence of light waves by means of a system of lenses. One diopter means that the lenses will focus light waves on a point from a distance of one meter. The human dioptric value is sixty.
- Diplopia:** Double vision; seeing objects as double.
- Dipsomania:** Pathological\*, insatiable craving for alcohol\*.
- Discrimination:** Act of perceiving differences between two or more objects.
- Disinhibition:** A previously extinguished conditioned\* response may be elicited a few times if extraneous stimuli\* are suddenly presented. The inhibition\* built up as a result of the extinction process undergoes momentary inhibition. Inhibition of an inhibition.

**Disparate points:** Points on the retina\* of the eyes which play a part in giving sensations of two objects rather than one. See *corresponding points*.

**Dissociated personality:** A condition wherein the individual loses ability to co-ordinate his behavior, so that his activities remain separate from each other. Such an individual may fail to recall his past experiences. See *dissociation*.

**Dissociation:** Either sudden or gradual cleavage, or break up, of anything into its parts. See *dissociated personality*.

**Dissonance:** Tones\* which do not fuse are experienced as rough, inharmonious, and usually unpleasant sounds.

**Distraction:** Whatever changes one's attention\* from relevant to irrelevant stimuli\*.

**Distribution:** A table which includes the range of scores earned on a test as well as the number of subjects who achieved each score. When these scores and their frequencies are plotted on a graph, a *normal\* distribution curve* results. See *average, central tendency*.

**Dominance:** (1) Cerebral—the left hemisphere of the brain is dominant or ascendant in function in the right-handed person; (2) heredity (genetics)—one gene complex (gene and chromosome) which is able to suppress a given characteristic also present in the germ plasm. Mendel's law of dominance-recessiveness; (3) personality-reaction tendency or trait characterized by ascendant behavior. Opposite of submissiveness; (4) control over.

**Dorsal:** Back part or rear section.

**Double aspect theory:** Mind and body are held to be identical. Common substance seen from without is body, from within is mind or consciousness. The terms "mental" and "physical" are merely different words for different aspects of the same set of events and the same substance.

**Doubt:** A state of fluctuation between belief\* and disbelief, wherein acceptance and rejection of an idea may alternate with each other.

**Drainage theory:** The theory that learning takes place when sensory stimulation initiates brain impulses that travel throughout an entire physiological area, spreading through the central\* nervous system and forming nerve paths or patterns of reaction.

**Drill:** Repetition of a task in order to achieve knowledge or skill. See *exercise, effect, readiness*.



- Drive:** The internal condition or conditions which arouse and sustain activity. A study of drives is important because motives\* are modified drives by way of learning, and because drives and motives teach us the nature of the "springs to action." See *incentive*.
- Drugs:** Habit forming substances narcotic in their effects.
- Dualism:** The theory that mind and body differ basically from each other. See *monism*.
- Duct glands:** Glands\* which secrete their fluids by way of canals or ducts on the surfaces of organs. Examples are the sweat glands and the kidneys. Also called *exocrine* glands.
- Ductless glands:** Glands\* which secrete hormones\* directly into the blood stream. Examples are the thyroid gland and the adrenal glands. Also called *endocrine* glands.
- Duplicity theory:** The theory that the cones\* mediate daylight and color vision, while the rods\* mediate twilight and achromatic\* vision.
- Dwarfism:** Failure to grow to the average\* or natural size. Radically stunted growth which may be due to undersecretion of the anterior\* lobe of the pituitary\* gland. See *cretinism*, *myxoedema*.
- Dynamic:** Changing, the opposite of static or fixed.
- Dynamometer:** An instrument used to measure muscular strength.
- Eclecticism:** The selection of the best from among numerous views, and the organization of the selected items in the form of a new interpretation.
- Edipus complex\*:** A mother complex on the part of a son. See *Oedipus complex*, *Electra complex*.
- Educational age:** The achievement of a child in school, calculated on the basis of the average\* performances of children at various ages. Indicates average achievement of pupil in several subjects. E. A.  $\div$  C. A. yields the E. Q., or Educational Quotient. See *achievement age*, *chronological age*, *mental age*.
- Educational quotient:** See *educational age*.
- Effect, law of:** The principle of learning, formulated by Thorndike\*, which states that the successful response is readily selected, while the unsuccessful or annoying response is eliminated in learning. This law was formulated early in the twentieth century to account

for selection and elimination in trial-and-error\* learning. Today the principle has undergone modifications, although the factor of satisfyingness is still used to account for the selective characteristic in learning.

**Effectors:** Muscles and glands activated by motor nerve disturbances or excitations\*.

**Efferent:** Motor nerve conduction from nerve centers to the peripheral muscles and other response mechanisms. See *afferent*.

**Effort:** Strain which accompanies voluntary action in the face of obstacles. See *fatigue, interest*.

**Ego:** One's conscious self. See *unconscious, subconscious, censor*.

**Egocentric:** Self-centered.

**Eidetic image\*:** A very clear visual image of a previous experience, projected into space. The image is so clear that it seems objective rather than subjective to the person. Investigated by Jaensch\* and used by him for the construction of a theory of personality\* types. See *memory after-image*.

**Eidetic individual:** One who is able to project mind pictures of a very clear sort. Usually prevalent during childhood\* and early adolescence\*.

**Electra complex:** Father complex by a daughter. See *Edipus complex*.

**Electroencephalograms:** Recordings of brain\* waves of electricity from the cortex\*. There are three types of waves: alpha\*, beta\*, and delta\*.

**Embryo:** The unborn mammal during the early stages of its development.

**Emergency theory:** Theory of the emotions\*, formulated by W. B. Cannon\*, which states that strong emotion is the result of interplay of neural messages between the cerebral\* cortex\* and the thalamus\*.

**Emotion:** A stirred-up condition of the organism accompanied by subjective feelings\* designated, upon different occasions, as either anger, fear\*, love, grief, or any composite of the more fundamental experiences.

**Emotional maturity:** The extent to which an individual, in comparison with others of his age level, controls his emotional reactions.

**Emotionality:** The speed and strength of one's emotional responses.

- Empathy:** The projection of the self into objects in space. "Feeling with" characterizes this reaction.
- Encephalon:** The brain\*.
- Endbrush:** The terminations of axones\*.
- Endocrine gland:** A ductless\* gland producing and secreting into the blood complex chemical substances called hormones\*. See *duct glands*.
- End-organ:** Any receptor mechanism.
- Endowment:** Capacity\* determined primarily by one's heredity.\*
- End-plate:** Terminations of motor nerves in muscle tissue.
- Enervate:** To diminish in vitality or energy.
- Engram:** The effect of excitation\* and conduction upon central nervous tissue, resulting in, it is assumed, a permanent modification of the tissues. This change is believed to be the basis for memory\*.
- Entelechy:** For Aristotle\* a term signifying that which determines the course of thought and action. The soul\*.
- Epinephrin:** See *adrenin*.
- Epistemology:** The study of how man gains knowledge.
- Equilibrium:** Balance, upright posture. See *semi-circular canals*.
- Equipotentiality:** An undestroyed portion of a functional nerve center may take over the functions which have been lost by the destruction of parts of the center. The cortex acts as a whole rather than through centers. Theory formulated by K. S. Lashley\*.
- Equivalence:** Term designating that (1) certain stimuli\* may induce qualitatively similar responses; (2) dissimilar stimuli may induce qualitatively similar or equivalent responses. These processes are spoken of as stimulus and response equivalence.
- Ergograph:** An instrument used to study changes in muscular contraction as in fatigue\* experiments.
- Escape mechanism:** Any reaction to difficulties which takes the individual away from the problem, thereby resulting in an avoidance of the situation. See *adjustment mechanism*.
- Esoteric:** Term used to designate mystical theories. Secret, hidden.
- Esthesiometer:** An instrument used to measure tactual acuity.
- Etiology:** A study of causes.
- Eugenics:** That social movement which favors the improvement of the human race by controlling hereditary factors. To do this those

who favor the movement recommend the sterilization of the unfit and the regulation of the marriages of those biologically superior in such a way that they will produce superior offspring. See *Galton*, *euthenics*.

**Euphoria:** State of bodily well-being.

**Euthenics:** That social movement which favors the improvement of the human race by controlling the environment. To do this it is advocated that slums and other undesirable environmental conditions be improved. See *eugenics*.

**Excitability:** Property of living tissue which makes stimulation possible.

**Excitation:** (a) The process whereby a stimulus\* affects a particular region within the brain\* and sends a wave or impulse that travels over the entire area about the region. (b) Nerve impulse or propagated disturbance in a nerve.

**Exercise, law of:** In trial-and-error\* learning, the repetition of an act strengthens the connection by (it is assumed) lowering synaptic resistance to the passage of the nerve impulse. This law was formulated early in the twentieth century by Thorndike\* to account for fixation in trial-and-error learning. More recently the principle has been modified to account for learning when the subject comprehends the relationship between the items of the problem to be learned. See *belongingness*; *drill*.

**Existential psychology:** That school of psychological thought which stresses the study of conscious\* experiences. Titchener\* and the Structuralists are of this school. See *functional psychology*.

**Exophthalmic goiter:** A goiter condition characterized in part by protruding eyeballs and caused by excessive secretion of thyroxin\* as a result of disease in the thyroid\* gland.

**Experiment:** A series of scientific observations made under controlled conditions. Only one independent\* variable is permitted in order to study the effect of this one factor upon the dependent\* variable, a selected behavioral index. See *scientific method*, *control group*.

**Experimental group:** In a scientific experiment, the factor to be analyzed is applied to this group. The reactions of the experimental group are then compared with those of the control\* group.

**Experimental psychology:** Psychology viewed as an experimental science\*, discovering facts and principles by means of scientific experiments\*. See *scientific method*.

**Expression method:** Study of the emotions\* by observing another's responses in situations which induce emotional responses.

**Exteroceptor:** Receptors\* stimulated by energies external to the skin. See *proprioceptors, interoceptors, connectors*.

**Extinction:** Partial or complete loss of a conditioned\* response as a consequence of an absence of reinforcement by the unconditioned\* stimulus.

**Extirpation:** Surgical removal of parts, for experimental purposes.

**Extrinsic:** Outward, foreign, extraneous. See *intrinsic*.

**Extroversion (extraversion):** A trait\* of personality\* characterized by world-centered interests. Extroversion, introversion, together, comprise one trait of personality. In respect to the possession of this trait, most people are *ambiverts\**, that is, they lie within the two extremes as far as scores earned on extroversion-introversion tests are concerned. See *ascendancy, submission*.

**Facilitation:** That which makes any performance easier.

**Factor analysis:** A statistical technique in psychology and mathematics whereby independent factors to account for particular reactions can be isolated. See *G factor*.

**Faculties:** Mental powers formerly accepted as compartments of the mind. See *faculty\* psychology*.

**Faculty psychology:** An early conception of mind which assumed mind to consist of specifically isolated and localized powers such as memory\*, perception\*, judgment\*, volition\*, etc. Each faculty or power was believed in control of particular patterns of behavior. See *formal discipline*.

**Farsightedness:** Ability to see distant objects clearly and near objects less clearly, because of defects within the eye.

**Fatigue:** Decrease in ability to work, as a result of prolonged effort\*. Toxic accumulations cause a feeling of weariness and may reduce efficiency. At times, however, the individual increases his efforts and overcomes the effects of fatigue.

**Fear:** One of the primary emotions\*, leading the organism to avoid



or to escape from the stimuli\* feared. Fears may be developed as a result of experience. See *emotion*, *phobia*.

**Feeble-mindedness:** Mental deficiency present at birth or shortly after birth. The term includes all those who are classified on the basis of tests of intelligence as morons\*, imbeciles\*, or idiots\*. A large percentage of those designated as feeble-minded is believed to be due to defective germ plasm. Birth injuries, poisons, and other factors account for the remainder. The feeble-minded are designated by the members of the medical profession as *amented* individuals. See *pathology*, *abnormality*, *cretin*.

**Feelings:** Affective accompaniments of conscious experience designated in degrees of pleasantness and unpleasantness.

**Fetishism:** An abnormal\* condition in which sexual satisfaction is secured by observation of body parts or of articles of clothing worn by a particular person.

**Fetus:** The unborn organism in its later stages of development.

**Field:** (1) Attention\*—the range of stimuli\* at any given instant capable of eliciting the preparatory act of adjustment known as attention; (2) consciousness\*—all experience that one is aware of at a given moment; (3) regard—all that which the moving eye can encompass; (4) vision\*—all visual stimuli at one moment which are in positions suitable for excitation\* of receptor\* cells in the non-moving eye.

**Figure-ground:** In perception\*, certain parts of the field\* will be clear and others less clear. Those clearly attended and perceived compose the *figure*, while those less clearly seen encompass the *ground*. Between these a dynamic interaction exists. What is field at one instant is ground the next. See *Gestalt psychology*.

**Filial regression:** Galton's law which states that individuals tend to approach the average height of their parents and the human race.

**Fissures:** Brain surface indentations or furrows. See *convolution*.

**Fixation:** (1) Vision\*—focusing the eyes upon an object so that the images fall upon the foveas\* of the eyes; (2) learning—the establishment of a well learned response; (3) personality—arrested development of an individual in a psychosexual sense.

**Fixed ideas:** Unchanging and recurring thoughts. Obsessions. See *delusion*, *illusion*, *hallucination*.

- Flexion:** Bending of a member of the body at the joint.
- Flicker:** Rapidly recurring changes in visual and auditory perceptions\* as a result of rapid presentation of stimuli\*.
- Fluctuation, attention:** Alternate presence and absence of awareness of stimulation.
- Focus:** The point at which light rays from an object in space converge within the eye. See *accommodation, convergence*.
- Forebrain:** The cerebrum\*.
- Forgetting:** Permanent or temporary loss of previously acquired acts or information. See *retention, memory, recall, Ebbinghaus*.
- Formal discipline:** The early doctrine that the mind can be trained by drill in difficult subjects. The theory assumed that the more one memorized the better one's faculty of memory\* would be thereafter. See *faculty psychology*.
- Fovea:** A small pit-like area, in the central portion of the retina\*, possessing only cone-cells. The fovea is the region of clearest vision and the center of fixation\*. See *convergence*.
- Fraternal twins:** Two babes born at a single delivery, but not of the same fertilized egg. See *identical twins*.
- Free association (association test):** Immediate and unrestricted verbal responses to stimuli, without delimiting instructions. The subject responds with the first word which occurs to him.
- Free-will doctrine:** The belief that man may direct his own behavior without reference to external and internal stimulating conditions. A form of indeterminism.
- Frequency:** (1) Physics—the number of oscillations or cycles per second of a sound or light wave; (2) statistics\*—the number of people making the same score on a psychological test; (3) learning\*—the principle of learning\* which holds that repetition of an act leads to further repetition and in this way makes for fixation\*.
- Frequency histogram:** A diagram, in the form of blocks, which shows the frequency of cases in a distribution\*.
- Frequency polygon:** A graph\*, in the form of a line curve, which shows the frequency of cases in a distribution\*.
- Frequency table:** See *distribution*.
- Frontal lobes:** That portion of the brain\* lying anterior to the central fissure\* and dorsal to the fissure of Sylvius. See *parietal lobe, occipital lobe*.

**Frustration:** Thwarting of motivated behavior by obstacles which permit of no solution. No adequate habit\* pattern permits adjustment\* at the time. See *adjustment mechanism*.

**Functional disorder:** A disorder of which no organic cause is known.

**Functional psychology:** A school of psychological thought which stresses the study of mental processes in relation to their use in environmental adaptation. Early emphasis was given by John Dewey\* and James Angell\*. See *structural psychology*, *existential psychology*.

**Functionalist:** An adherent of the school of functional\* psychology.

**Fundamental tone:** The tone\* of lowest frequency in a tonal complex.

**Fusion:** A combination of several stimuli within one sense modality. The resulting unanalyzed sensation is called a *blend*.

**G factor:** According to the English statistician-psychologist, Spearman\*, the general factor or determiner of one's performance on an intelligence\* test. People are held to differ in the degree to which they possess this general ability to adapt to new situations. See *factor analysis*.

**Galvanic skin reflex\*:** Involuntary reaction to stimuli\*, characterized by decreased skin resistance to the passage of a weak electric current. The skin reflex is one indirect method by which to measure the stirred-up condition of man during an emotional experience. Often abbreviated as PGR for psychogalvanic reflex. *Galvanic* refers to the fact that the change in resistance to the passage of an electric current is shown by a galvanometer\*. See *psychogalvanic reaction*.

**Galvanometer:** A sensitive instrument for the measurement of weak electric currents. Used in the study of bodily changes during emotion\*.

**Ganglion:** A group of nerve cells *outside* the brain\* and spinal\* cord. A group of nerve cells *within* the brain is called a *nucleus\**.

**Gaussian curve:** The normal\* distribution curve, so named after its originator, the mathematician Gauss (1809). See *bell-shaped curve*, *skewness*.

**Gene:** The factor or series of factors within the chromosomes\*, active in the determination of inherited characteristics.

**General ability:** All-round intellectual ability as measured by batteries\* of intelligence\* tests which disclose types of capacities by way of problems. General intelligence.

**General intelligence:** See *general ability, intelligence*.

**General psychology:** The scientific study of the activities of the normal\* adult in adjusting to his environment. See *psychology*.

**Generalization:** (1) A mental process of formulating a general principle on the basis of experiences, so that the principle has valid application to a large number of experiences; (2) the activity of responding to a new stimulus\* in much the same manner as one responds to familiar situations; (3) an explanation offered by Judd\* for transfer\* of training.

**Genesis:** Study of origins.

**Genetic method:** The scientific method used to investigate the changes which occur in behavior\* from conception to death. The method includes the *longitudinal* or day-book approach, the *cross-section*, and the *co-twin\** control procedures. Child psychology\* depends heavily upon the genetic method for its information.

**Genius:** A person of very marked mental ability. On age-scale\* intelligence\* tests an I.\* Q. of 140 or above is held indicative of genius. Less than one per cent of a population is believed to merit this rating.

**Gestalt:** A German word which means pattern, configuration\*, synthesis.

**Gestalt psychology:** A school of psychological thought which stresses the importance of investigating the effects of total stimulating situations upon behavior. The emphasis is placed upon total patterns as determiners of responses rather than upon analysis into elements. Since any stimulating complex is held to be greater than the sum of its parts, analysis can never be completely successful for providing a complete understanding of human and animal behavior. Wertheimer\* (1912) originated this system with his studies on apparent movement (Phi\* Phenomenon). Extensions and modifications have been made more recently by Koffka\*, Köhler\*, and Lewin\*. See *atomism, behaviorism, figure-ground*.

**Giantism:** Over-secretion of the anterior\* lobe of the pituitary\* gland in children results in marked increase in body size. See *cretin*.

**Glands:** Bodily structures which manufacture and secrete in different

ways chemical substances essential for normal\* life. These glands are of three types: the *endocrine\** or *ductless\** which secrete their hormones\* directly into the bloodstream; the *duct\* glands*, or *exocrines\** which secrete their fluids by way of canals or ducts upon surfaces of organs; and the *mixed\* glands*. These latter types, such as the pancreas, possess both exocrine and endocrine functions. The adrenal\* and the pituitary\* are endocrine glands, while the tear glands are exocrine in type.

**Gonads:** The sex glands which possess both internal and external mechanisms for secretion.

**Gradient:** That which increases or decreases by steps instead of maintaining a uniform rate.

**Graph:** A pictorial representation of relations between variables\* by means of lines, curves, bars. The learning\* curve is an illustration.

**Gray matter:** Cell-bodies\* of nerve\* cells within the spinal\* cord and the brain\*. Bundles of axones\* make up the white\* matter.

**Gregariousness:** The characteristic tendency of organisms to live in groups. Man is a gregarious animal because he associates with his fellows in common enterprises.

**Ground:** The background in any configuration\* according to Gestalt\* psychology. See *figure-ground*.

**Group test:** A test designed for administration to a class or group of pupils together. See *individual test*.

**Growth:** Any increase in size or mass.

**Gustation:** The sense of taste. The four taste qualities or experiences out of which all others are compounded are sweet, sour, salt, and bitter.

**Gyrus:** Any convolution or fold of the brain\*.

**Habit:** A relatively automatic and easily elicited acquired response. According to John Dewey\*, habit is purposive, directed toward goals or ends. Habit is a learned response and results from training or life experience.

**Habituation:** Adaptation, getting accustomed to.

**Hallucination:** An error of perception\* in which the person believes that he perceives objects as if they were present to his senses. Abnormal\* if he does not recognize the error. See *illusion*, *delusion*, *fixed ideas*.



**Halo effect:** In rating an individual, the rater is influenced greatly (in his ratings of certain traits) by some incident. The incident influences the rater's evaluations of all the other traits\* of the subject. This difficulty is overcome by having several judges rate the same person.

**Hedonic tone:** Feeling\* tone.

**Hedonism:** The theory that organisms adjust to their environments in such ways as to avoid unpleasant conditions or to attain pleasant states.

**Hemianopsia:** In this condition the visual field\* is limited by central neural\* defects so that vision\* is possible in only one-half of each eye.

**Hemiplegia:** Muscular paralysis on one side of the body.

**Heredity:** Physical and mental characteristics known to be determined (handed down) by the bearers of hereditary factors, the genes\* and chromosomes\* (germ plasm). These characteristics are said to be inherited. The science of *genetics*, begun by Gregor Mendel (1865), studies these problems. See *Mendelism*.

**Heterogeneous grouping:** The grouping together of pupils (for instruction) who possess a variety of abilities, of degrees of intelligence, or of other individual differences. See *homogeneous grouping*.

**Heterosexuality:** Normal attraction between male and female.

**Hierarchy, habit:** A group of habits organized from simple to complex, so that the more recently acquired habit necessitates the formation of the simpler one. In learning to typewrite, for example, the keyboard habit must be acquired before words and sentences can be typed readily.

**Higher mental processes:** A general term which includes perception\*, learning\*, memory\*, thinking, reasoning\*, and imagination\*, and which separates these activities from sensation\* and emotion\*.

**Holmgren Yarn Test:** A test for color-blindness\* by means of skeins of colored yarn.

**Homeostasis:** The process of physiological readjustment to one's environment in order to secure optimal living conditions and physiological equilibrium. Term first used by W. B. Cannon\*.

**Homogeneous grouping:** The grouping together, for purposes of in-

struction, of pupils with like intelligence, abilities, or other bases of classification. See *heterogeneous grouping*.

**Homolateral:** On the same side. *Contralateral* means on the opposite side.

**Homosexuality:** Abnormal attraction between two persons of the same sex.

**Hormic theory:** A current psychological interpretation of human behavior, in terms of purposes and urges used as keys to the understanding of man's response patterns. William McDougall\* was a well known exponent of this view.

**Hormones:** Complex chemical substances produced and secreted by the endocrine\* glands. Hormones are carried by the blood stream to various parts of the body. They are essential to physical and mental development. See *thyroxin*.

**Horofter:** That area in the field of vision within which all objects are seen as single rather than as double objects, because the retinal images fall on identical or corresponding\* points in the two eyes.

**Hue:** Color.

**Hypacousic (hypacousis):** Slightly deaf or hard of hearing. The hypacousic individual finds it difficult to distinguish some of the words in conversation. See *deafness*.

**Hyperfunction:** Over-activity. Excessive functioning of a gland or organ. The opposite of *hypofunction*.

**Hyperkinesis:** Excessive bodily restlessness. See *neurasthenia*.

**Hypermetropia:** Farsightedness\*. See *myopia*, *hyperopia*.

**Hypermnnesia:** Marked increase in the ability to recall\* experiences. The condition is found in certain abnormal\* states. See *memory*, *retention*.

**Hyperopia:** Farsightedness\*. The same as hypermetropia\*. See *myopia*.

**Hyperthyroidism:** Oversecretion by the thyroid\* (endocrine\*) gland. See *hypothyroidism*.

**Hypnagogic image:** An image\* which occurs during drowsy periods just prior to sleep.

**Hypnosis (hypnotism):** A condition, resembling but not identical with sleep, characterized by an extreme degree of susceptibility to suggestion. Studied first by Mesmer (mesmerism) and later investigated scientifically by Braid\* (1842). See *suggestibility*.

**Hypochondriac:** One who is abnormally anxious about his health and who is given to concern about minor aches and pains. Is considered an escape\* mechanism.

**Hypophysis:** The pituitary\* gland.

**Hypothalamus:** A region within the brain and structurally below the thalamus\* proper which is essential for emotional reactions according to Cannon's Emergency Theory of the emotions\*. See *Cannon*.

**Hypothesis:** A tentative guess formulated to explain collected observations. Sometimes expressed as having a 50-50 chance of being correct.

**Hypothyroidism:** Underfunction of the thyroid\* gland, a condition sometimes causing cretinism\* and myxoedema. See *dwarfism*, *hyperthyroidism*.

**Hysteria:** A psychoneurotic\* condition characterized by dissociation\* and amnesia\* as well as by the induction of various substitute responses and experiences, such as pains, paralyses, anaesthesias, fugues, somnambulisms, and emotional seizures. Studied in great detail by the French investigator, Pierre Janet\*.

**Id:** For Freud\*, the sum total of all instinctive tendencies purely hedonistic\* in tone. The Id is unconscious\* and primitive.

**Idea:** A symbol (image, word, gesture) which stands for a previous experience and which acts as a tool in thinking. See *concept*.

**Ideal:** A principle or standard accepted as a basis for behavior.

**Ideational:** Related to the formation and manipulation of ideas\* or symbolic processes (thinking).

**Identical elements:** An explanation offered by Thorndike\* to account for transfer\* of training from one situation to another in terms of items common to the two situations.

**Identical points:** Any two retinal points in the eyes which receive light rays from the same point in space, provided the eyes are in the primary position. See *corresponding points*.

**Identical twins:** Two children born at a single delivery from the same fertilized egg. They develop by the splitting of a single ovum. Their inherited characteristics are believed to be very much alike. They are much more alike in features (even in finger prints) than fraternal\* twins.

**Identification:** An adjustment\* mechanism by which one attains satis-

faction by projection of the self into those who possess the desired goals. Identification of the self with a motion picture star is illustrative.

**Ideomotor:** Responses initiated by ideas\* or by thought processes.

**Idiosyncratic response:** An individual's response that is radically different from the responses most people give to a stimulus.

**Idiot:** A mental deficient of the lowest grade. I.\* Q. range from 0 to 20 or 25. See *amentia*, *feeble-mindedness*, *imbecile*, *moron*.

**Idiot-savant:** A feeble-minded\* individual who has unusual ability in some field such as art, music, mathematics, or the like. Are imbeciles or morons, not idiots.

**Illiteracy:** Inability to read or write any language.

**Illusion:** A misinterpretation and distortion of objects present to the senses. See *hallucination*.

**Image:** A mind picture. The image goes beyond immediate sensation\* and may take the form of visual, kinaesthetic, auditory, touch, or other mind pictures.

**Imageless thought:** The theory (1910) which holds that ideas\* can mediate thought without the use of mind pictures, or images.

**Imagination:** The activity or mental process of combining old ideas\* into a new one on the ideational\* level. Old experiences in recall\* are essential inasmuch as no one can imagine anything which has not been previously experienced in some way. The role of imagination in creative thinking influences the nature of new hypotheses\* suitable for verification and application.

**Imbecile:** A mental defective, with an I.\* Q. range from about 25 to 50. See *moron*, *idiot*, *feeble-mindedness*.

**Imitation:** The process of copying the behavior of others. John Dewey\* believes imitation to be a purposive activity that uses the methods observed to have been used successfully by others.

**Implicit:** A meaning implied or assumed in a statement, but which is not definitely expressed.

**Impression method:** A study of the affections\* by means of the introspective\* method.

**Impulse, neural:** A propagated disturbance, conducted along a nerve\*, which elicits reactions.

**Inadequate stimulus:** A stimulus\* which is less appropriate for the

excitation\* of a receptor\* mechanism than is some other stimulus. A blow on the eye is less appropriate than is light for eliciting a visual sensation\*.

**Incentive:** An external stimulus\* which directs behavior toward the goal. Water is the incentive for a thirsty animal. See *drive, motive*.

**Incipient:** The beginning of.

**Increment:** Increase in.

**Independent variable\*:** In an experiment every factor, save one, must be kept constant. This one, which may vary according to the discretion of the experimenter, is the independent variable. In the study of the effect of loud sounds upon efficiency at work, the loud sounds constitute the independent variable. See *control experiment, dependent variable*.

**Indeterminism:** See *determinism*.

**Individual differences:** Variations in performances of individuals on any psychological test. Such variations may also appear in the same person at different times and under different conditions. The study of these variations constitutes *individual* or *differential* psychology. Inasmuch as each individual is unique psychologically, the measurement of these differences from person to person is of theoretical and practical importance.

**Individual psychology:** See *individual differences*.

**Individual test:** A test designed for administration to each individual separately. See *group test*.

**Individuation:** The process by which specific physical reactions evolve from mass responses. Observed clearly when the genetic\* method is applied to the study of infant\* and child\* behavior.

**Induction:** The process of arriving at conclusions or generalizations\* on the basis of particular facts. Reasoning from the specific to the general. See *deduction, reasoning, scientific method*.

**Inertia:** The tendency to maintain a condition or mode of response; resistance to change.

**Infancy:** The first year or two of childhood\*.

**Inference:** A conclusion derived from indirect evidence.

**Inferiority feeling:** An attitude of inadequacy acquired usually as a consequence of early experiences and faulty training. Alfred Adler maintains that man is born with this tendency to develop what he



termed the "inferiority complex." Recent evidence indicates that feelings of inferiority are acquired as a consequence of environmental conditions. See *adjustment mechanism*, *superiority complex*.

**Inherent:** Existent within.

**Inhibition:** Prevention of a response to a stimulus\*.

**Inhibition, retroactive:** A means whereby new learning impairs the retention\* of recently formed, though previous, associations or memories. First investigated by G. Müller\* and later by John McGeoch.\*

**Ink-Blot Test:** A clinical procedure devised by Rorschach for the determination of the nature of complexes\*. The test consists of ten ink-blot patterns, each of which the subject describes in terms of what it suggests to him.

**Innate:** Inborn.

**Innateness:** The quality of being innate\*.

**Inner speech:** Auditory and motor means of recall\*. The subject recalls words by reproducing the original muscular sensations which he experienced when he previously uttered the words.

**Innervation:** (1) Nerves which are connected with any organ system are said to innervate or supply these organs with efferent nerves. (2) double innervation—organ systems of the body which are supplied by two sets of efferent nerves with different functions. Muscles of the arm are supplied with motor nerves which excite contraction and with motor nerves which elicit extension of the arm.

**Insanity:** A social and legal term designating a mental condition which prevents normal adjustment in society. The medical term is *psychosis*\*.

**Insight:** A sudden solution of a problem, without the need of previous experience in this problem situation. See *Gestalt psychology*.

**Instability:** A state characterized by numerous changes in behavior, usually emotional\* in nature. Absence of the usual degree of consistency in behavior.

**Instinct:** The hypothesis\* that man and other animals possess inherited co-ordinated, complex response patterns which are elicited by a stimulus\* without previous opportunity to learn.

**Instrumental conditioning:** Conditioning\* in which the conditioned\* or inadequate stimulus elicits a generalized adaptive response

instead of a specific and localized response. Thus, an animal may learn to avoid an electric shock by reacting to a buzzer-signal that serves as a warning of the oncoming shock. In this way, the conditioned\* response itself is instrumental in reinforcing the reaction.

**Insulin:** The hormone\* secreted by the islands\* of Langerhans in the pancreas.

**Insulin shock:** A recently devised method for the treatment of certain cases of functional\* psychoses\*. Injections of insulin deplete the body's supply of sugar, resulting in coma. Injections of sugar solution result in a return to wakefulness and to sanity in numerous cases thus far reported. Method devised by Vienna physicians, Sakel and Wortis.

**Integration:** The process by which reaction tendencies (traits\*, generalized habits\*) are organized to ensure co-ordinated action in the control of behavior\*.

**Intelligence:** Variously defined. Some define intelligence as the capacity to profit from past experience when dealing with new problems. Roughly equivalent to mental efficiency. Intelligence is quantified by means of the administration of tests of intelligence. The first of these was worked out by Binet\* and Simon, 1905. Intelligence has sometimes been subdivided into verbal (ability to deal with problems on paper); mechanical (ability to perform mechanical work); social (ability to get along successfully with others); and aesthetic (ability or talent in the creative arts). According to Spearman\* intelligence is based upon a general ability or g\* factor and special abilities or s factors. Thurstone\* attributes intelligence to groups or clusters of primary abilities. See *achievement*, *aptitude*, *mental age*, *ability*.

**Intelligence quotient:** See *I.Q.*

**Intelligence test:** A standardized\* psychological test consisting of a series of problems of increasing difficulty and used for the determination of how intelligently a person performs. Scores earned on these tests may be reported either in terms of developmental months (age-scales\*) or in point scores (point\* scales). See *achievement*.

**Interaction:** The interdependent actions of two or more forces. E.g., learning depends in part on the degree of development of the

neuromuscular system, and the development of that system also depends in part on exercise and learning.

**Interactionism:** The theory that mind may influence bodily processes and that these in turn may influence mental activities.

**Interest:** Intrinsic interest is a mental set, a direct concern, applied to a task, or external stimulus, for its own sake. Extrinsic interest is concern with a task or stimulus for sake of some factor external to but associated with the task or stimulus.

**Interest schedule:** A scale devised by Strong in 1927 to measure the nature and degree of occupational interests among young men and women.

**Interoceptor:** All receptor\* cells activated by internal stimuli. See *exteroceptor*, *proprioceptor*.

**Interview method:** The study of generalized habits by direct questioning of individuals.

**Intrinsic interest:** See *interest*.

**Intrinsic motives:** Motives\* directed toward experiences for their own sake rather than for sake of extraneous rewards or consequences.

**Introspection:** Subjective observation as a method of collecting data.

**Introversion:** A trait\* of personality\* characterized by a degree of concern with the self rather than with the world and other people. See *extroversion*.

**Intuition:** A judgment\*, the source of which is not known by the individual.

**Involuntary:** Without effort, without control. See *interest*, *attention*.

**I. Q.:** Abbreviation for *intelligence quotient*, defined as a ratio between mental\* age and chronological\* age. M. A. / C. A. times 100 equals the I. Q. Index of brightness. See *basal age*.

**Irradiation:** Diffusion or spread of nerve impulses through the nervous\* system eliciting, in the infant\*, diffuse, generalized mass responses.

**Ishihara Test:** A test of color-blindness\*.

**Island of Reil:** A portion of the cerebral cortex\* lying buried within the Fissure of Sylvius, in primate and human brains. Functions in hearing.

**J. n. d.:** The abbreviation for the unit of measurement of the just

perceptibly different intensities of sensations in psychophysical experiments. The just noticeable difference. See *difference limen*.

**James-Lange Theory:** A theory of emotional behavior which holds that the perception\* of organic changes in the viscera\* and the skeletal musculature constitutes the emotional experience. James\* formulated this theory in the early 1880's at about the same time that the Danish physiologist, Lange\*, formulated a similar interpretation. Both are given credit by designating the theory as a joint contribution.

**Job analysis:** Study of the functions performed by employees, whereby the skills and other qualifications for a job can be determined.

**Jost's Law:** Given two associations which have been brought practically to the same level of learning\*, though practice has been given at different periods of time, the repetition of the older association\* strengthens it to a greater extent than repetition strengthens the more recently acquired association.

**Judgment:** The process of applying a principle to a set of facts so that a decision is reached concerning the applicability of the principle.

**Judgmental theory:** The theory, formulated by Carr\* in 1925, that feelings of pleasantness and unpleasantness are judgments\* based upon one's past experiences in similar situations.

**Katabolism:** See *catabolism*.

**Kent-Rosanoff Test:** A free association\* test so standardized\* by using normal\* and abnormal\* subjects\* that all verbal responses of further subjects can be classified as commonplace, unusual, or doubtful. A clinical method used to study the thought processes of normal and abnormal individuals.

**Kinesthesia (kinesthetic sense, kinaesthesia):** The sense of muscle movement; awareness of muscular response.

**Kleptomania:** A form of compulsive behavior characterized by a tendency to steal for the pleasure of stealing.

**Korsakoff's psychosis\*:** The failure to recall correctly, caused often by continued overindulgence in alcohol. The patient tends to falsify events of the past.

**Korte's Laws of apparent movement:** When two neighboring lines are exposed successively, the best apparent movement varies with

the distance between the lines and the intervals between exposures. In general, the greater the distance the shorter must be the interval, but the relation is not direct, for the interval decreases more slowly than the distance increases. Total and relative intensities also affect the apparent velocities.

**Krause end-bulb:** Receptor\* mechanisms located in the skin on various parts of the body and believed to be the end organs for sensibility to cold.

**Kymograph:** A revolving drum, covered with smoked paper, used as a time-interval record for stimulus\* presentations as well as for the measurement of the size and time of the responses made by the subject. Frequently used in the study of bodily changes which occur during emotional experiences.

**Labyrinth:** (1) A maze\* used in the study of trial-and-error\* learning; (2) an organ, in the head region, containing sense receptors\* for hearing and for body balance. The term *labyrinthine sense* applies only to the sense of balance and position.

**Lag:** Sensations\* often persist after the stimulus\* has been removed. This process is called sensation lag.

**Latent period:** The time interval between stimulation and initiation of response.

**Lateral:** On the side.

**Law:** A generalization\* or principle based on scientific evidence; a rule that applies universally to relevant collected data.

**Learning:** Any modification in human and other animal behavior\* as a consequence of the acquisition of new stimulus-response relationships. Man learns by means of association\*, trial-and-error\*, conditioning\*, and insight\*.

**Learning curve:** A graphic representation of the performances of an individual during the acquisition of a new skill, idea or words. The x-axis\* of the learning curve is either in terms of the length of practice period or in trials. The y-axis\*, or ordinate, represents the number of errors made per interval or the number of errors or successes per trial. The shape of the learning curve tells the psychologist much about the activity of learning.

**Leptosome:** According to Kretschmer, a person with a body build which can be described as "long and lean." Occasionally, the athletic and asthenic are grouped together under leptosome.



**Lesion:** Any injury to body tissue. In psychology, the term usually refers to areas destroyed surgically in experimental studies on the animal brain.

**Libido:** In psychoanalytic theory, the libido is equivalent to psychic energy which initiates and directs the expression of the instincts\* assumed by Freud\* to exist. By many, the libido is interpreted as the sex drive\*, broadly conceived.

**Limen:** The threshold which limits the range of effective stimuli\*. The lower limen for hearing quality is about 16 double vibrations per second. This statement means that below this physical value man does not hear. Above this value he does. The lower the limen the greater the sensitivity of any sense receptor\*. The *terminal*, or upper, limen, above which man does not hear, is about 18,000 double vibrations per second. The term is also applied to the least difference between two stimuli which can be discriminated. See *difference limen*, *j. n. d.*, *absolute limen*.

**Limen of twoness:** The least distance at which two points applied to the skin are perceived as two points. On the finger tip the distance is 1 millimeter. On the back, the distance is between 40 and 60 millimeters.

**Lobes, brain:** Portions of the cerebral cortex\* called frontal\*, parietal\*, occipital\*, temporal\*, and central (island\* of Reil). See *gyrus*.

**Localization:** The theory that the human brain\* is divided into a series of functional compartments, each controlling a particular function of the subject.

**Local sign:** An assumed differential quality, localized in each receptor\* cell or in each sensory nerve\* fiber, by which man can locate the point at which a stimulus\* is applied. Theory formulated by Lotze (1817-1881), a German philosopher-psychologist, to account for tactual localization\*.

**Locomotion:** Bodily movement in space.

**Locomotor:** By means of or pertaining to locomotion\*.

**Locomotor ataxia:** A diseased condition of parts of the spinal\* cord, which results in marked inco-ordination in movement and in the absence of the kinaesthetic\* sensations that arise normally from peripheral stimulation.

**Logic:** A branch of philosophy which studies the accuracy of conclusions that have been reached by means of the reasoning\* process.

**Logic tight compartments:** An adjustment\* mechanism wherein the individual escapes from the necessity of meeting a problem by keeping the various aspects of the problem separated from each other. See *escape mechanism*.

**M. A.:** See *mental\* age*.

**Macula lutea:** Literally a *yellow\* spot* located near the center of the retina\* and containing the *fovea\**.

**Malingerer:** One who pretends to be ill, usually to escape facing difficulties. In these instances malingering is an escape\* mechanism.

**Mania:** A pathological\* state characterized by great emotional excitement. See *insanity*.

**Manic-depressive psychosis:** A functional psychosis\* which exhibits marked periods of excitement and depression.

**Masculine protest:** According to Alfred Adler\*, the tendency on the part of women to compensate for their felt inferiority to men by their manner of dress, their mannerisms, or their participations in certain vocations.

**Mass action:** The theory which holds that behavior\* is psychologically dependent upon the whole nervous\* system rather than upon isolated segments. Out from these mass reactions *individuate* more specific patterns of reaction. See *individuation*.

**Massed repetitions:** Continued practice until a new response is well fixated\*. Is less advantageous than *spaced practice*.

**Maturation:** The process whereby normal\*, complete development, physically and mentally, is achieved. Often defined as the progressive increase up to maturity\* in complexity of structure for function. Ripening.

**Maturity:** The age period in which one's organs and powers function in their full development. The stage of relatively completed growth. See *maturation, childhood, adolescence*.

**Maze:** An apparatus consisting of pathways only one of which leads directly to an incentive\* (e.g., food). It is used in the study of trial-and-error\* learning. A labyrinth of pathways.

**Mean:** The sum of the raw\* scores divided by the number of cases. One measure of the average\*. A measure of central\* tendency. See *median, mode, standard deviation*.

**Mean deviation:** See *average deviation*.

**Measurement method:** Any procedure used to quantify what men do under standardized conditions.

**Mechanical ability:** One's ability to solve mechanical problems. See *intelligence*.

**Mechanical intelligence:** See *mechanical ability, intelligence*.

**Mechanism:** A working assumption in science\* which holds that the living organism functions under much the same principles as a machine. An analysis of the parts will thus lead to an understanding of the dynamo, of the man. See the opposing doctrine of *hormic psychology, Gestalt psychology*.

**Medial fissure:** That furrow of the human brain\* which divides the brain into two hemispheres.

**Median:** The middle score in a series of raw\* scores when the scores are arrayed in order of their size. The score above which and below which there is an equal number of cases, when the cases are arranged in order of their size.

**Medulla:** The core of any structure, as of the adrenal\* gland.

**Medulla oblongata:** That portion of the brain\* stem which is directly connected with the spinal\* cord.

**Medullary sheath:** The myelin\* sheath which surrounds axones\* or nerve\* fibers.

**Meissner's corpuscles:** Receptors\* of the pressure sense.

**Melancholia:** An abnormal\* state marked by a depressed feeling tone. See *manic-depressive, pathology*.

**Memory:** A general term designating one's ability to reinstate previous experiences by means of responses to reduced\* cues. Reinstatements may take the form of a *rote*, or *verbatim*, recall\* of that previously learned, or *logical* recall. In logical memory one recalls the meaning of what has been learned. See *hypermnnesia, retention, recognition, amnesia*.

**Memory after-image:** A reinstatement, in mind pictures, of that which was just previously present to the senses.

**Memory image:** The mental picture of a previous experience which has long since been removed from sense impression.

**Memory span:** The number of items (words, digits, sentences) which a subject can correctly reproduce immediately after a single presentation by the experimenter.

**Memory system:** Any mnemonic\* device used to aid one's remembering. Memory "crutches."

**Memory traces\*:** The after-effects of experience which are the bases for associative learning through the integration of present with past experiences. See *engram*.

**Mendelism:** The inheritance of specific characteristics as a consequence of unit characters within the parent germ plasm. This theory, formulated by Gregor Mendel (1865) has been frequently utilized since 1900 in advanced research concerning the inheritance of physical and mental characteristics.

**Mental age:** That stage of mental development of a person determined by a comparison of his performances with the average\* performances for his chronological\* age. Abbreviated form is M. A. See *achievement age, intelligence*.

**Mental hygiene:** The study and practice of measures which aid in the attainment and maintenance of a healthy mind and body.

**Mental set:** An attitude\* or predisposition which influences the way one reacts to a given adequate\* stimulus.

**Mesencephalon:** The midbrain.

**Metabolic index:** A method of measuring the energy changes within an organism by comparing the amount of oxygen taken in and the amount of carbon dioxide given off.

**Metabolism:** A general term designating all energy changes within a living organism. See *catabolism, anabolism*.

**Metrazol:** Drug used in larger doses to induce convulsions\* in patients suffering from specific types of functional\* psychoses. Von Meduna, the Hungarian physician, has reported successful treatment of these cases by this method. Cardiazol.

**Micron:** A unit of measurement equal to one thousandth part of a millimeter.

**Millimicron:** One thousandth part of a micron, or a millionth of a millimeter.

**Mind:** A general term standing for all activities of which man is aware. Term is descriptive and non-explanatory.

**Mind-reading:** Muscle reading by means of slight cues\*. See *telepathy*.

**Mixed glands:** See *glands*.

**Mnemonics:** The use of formulae, or short sayings, to aid in recall.

"Thirty days hath September . . ." is an illustration of the "memory crutch."

**Modality:** Any one of the senses, such as vision\*, hearing, taste.

**Mode:** In a series of scores or items, the mode is the one that occurs most frequently. In a normal\* distribution, the mode is an acceptable average\*. See *median, mean, bimodal*.

**Monism:** The theory which holds mind and body are one and the same. See *dualism*.

**Monocular vision:** Visual perception with the use of only one eye.

**Mood:** A weak, though prolonged emotion.\*

**Morgan's canon:** A dogma in experimental\* psychology which holds that the simplest explanation is the best. This is also called the Principle of Parsimony\*, the Economy Principle, and Occam's Razor.

**Moron:** A mental defective with an I. Q.\* range from about 50 to 70. See *feeble-mindedness*.

**Motility:** The individual's characteristic way of moving about.

**Motivation:** The study of those factors which activate man and other animals toward goals. Motivation is the study of man's needs and wants; how these wants are satisfied. It includes a study of man's reactions to barriers which prevent him from always obtaining these goals.

**Motive:** A drive of the second order aroused by external stimuli essentially social in nature. Drives modified by learning and directed by incentives for their satisfaction are called motives, or second-order drives. See *drive, incentive*.

**Motor area:** A region, anterior to the central fissure of the brain\* and within the frontal\* lobe, which functions in muscular reactions. A cerebral projection\* area.

**Motor co-ordination:** Harmonious action of muscle groups so that normal locomotion is possible.

**Motor generalization:** The process whereby a conditioned\* stimulus may elicit one response under certain conditions and another equivalent response under other conditions. Thus, a stimulus may evoke on one occasion the movement of the right foot, and on another occasion the movement of the left foot. Response equivalence.

**Motor learning:** The acquisition of responses primarily locomotor in nature. The acquisition of motor skills.



- Multi-modal curve:** A curve which has two or more peaks or modes\*.  
See *bimodal*.
- Multiple fiber theory:** The theory that the strength or magnitude of a response to a stimulus depends on an increase in the number of sensory fibers stimulated. If the stimulus is applied to a larger area, a greater number of sensory nerve fibers are stimulated. There is thus a relationship between the strength of the stimulus and the intensity of the response.
- Multiple personality:** Dissociation\* or cleavage between traits\* of one personality\* into two or more relatively unrelated systems which alternate from one to another.
- Muscle tonus:** A condition of slight muscular contraction maintained by means of reflex\* adjustments within the neuromuscular system. Is essential for the initiation of locomotion.
- Myelin:** The white fatty sheath or covering around the core of the axone\* of a neurone\*. Myelinated axones comprise the white\* matter of the spinal\* cord and brain\*.
- Myopia:** Near-sightedness. See *hyperopia*, *hypermetropia*.
- Myxoedema:** Glandular disease caused by hypofunction\* of the thyroid\* gland. Often accompanied by mental deficiency.
- Native tendency:** An inborn propensity or inclination.
- Nativism:** The doctrine that a capacity or response is present at birth or develops later as a result of inheritance. In space perception\*, e.g., some writers assume that one perceives distance without learning.
- Negative adaptation:** The process whereby a reaction gradually ceases to occur in response to a stimulus that is presented many times.
- Negative after-image:** The complementary color that succeeds the stimulation of the eye by any color: e.g., red follows excitation\* by green.
- Negative transfer:** See *transfer*.
- Nerve:** A set or group of interconnected axones\*.
- Nerve fiber:** The axone\* of a neurone\* considered as part of a nerve\*. The element of a nerve.
- Nervous arc:** The mechanism of muscular reaction, including the sense organ, afferent nerve, neural center, and efferent nerve.
- Nervous system:** The total mass of nerve tissue in an animal. In verte-

brates, includes the brain\* and spinal column with the nerves that come to them from the sense\* organs and connect them with the muscles and glands.

**Neurasthenia:** Nervous breakdown, the third of the three major groups of psychoneuroses in Janet's\* classification. The victim of neurasthenia is unusually subject to fatigue\*.

**Neurilemma:** The thin white sheath that surrounds the nerve\* fiber.

**Neurobiotaxis:** The theory of C. U. A. Kappers that the growth of neurones\* depends on the development of new relationships between axones\* and dendrites\*, with growth taking place in an electric field and toward areas of increased stimulation. Tendency of a developing axone\* to grow towards a negative charge, towards active tissue. Also used to explain the formation of associations\*.

**Neuron (neurone):** The structural unit of the nervous\* system, a cell-body\* with its axones\* and dendrites\*.

**Neurosis:** A mild form of behavior abnormality\*, a disturbance of function and not of structure. Symptoms may be fixed\* ideas, anxiety\*, functional paralyses. Psychoneurosis.

**Neurotic:** See *neurosis*.

**Night blindness:** Defect of vision\*, resulting from lack of rods\*, so that faint lights cannot be seen.

**Nonsense syllable:** An artificial syllable devised to test learning, as *kuk* or *ges*.

**Non-verbal test:** A performance\* test.

**Non-voluntary attention:** See *attention*.

**Norm:** The average\* or typical individual. Has acquired a popular meaning of the correct or standard. This is probably derived from accepting the average as the standard. See *achievement age*, *standardization*, *age-scale*.

**Normal:** A condition which does not deviate too much from the average\*. A normal curve is the symmetrical or bell-shaped\* curve. See *abnormality*.

**Normal curve:** The bell-shaped\* curve.

**Normal distribution:** Form taken by plotted measurements of unselected data. When plotted they give a curve that is symmetrical and harmonizes with Gauss's formula.

**Nucleus:** A group of nerve cells within the brain\*. See *ganglion*.

**Nystagmus:** A twitching movement of the eyes, usually caused by stimulation of the labyrinth of the ear.

**Obesity:** Excessive fat. A condition of unhealthy corpulence.

**Object color:** Color ascribed to the surface of an object. It persists no matter how illuminated, and it is opposed to film color that changes with illumination. Also known as surface color.

**Objective method:** The observation of the behavior of an individual or group; includes watching their reactions and the use of instruments to measure or record their behavior.

**Oblivescence:** Forgetting, a term introduced by Ballard to oppose to the more infrequent cases of reminiscence. See *reminiscence*.

**Obstruction method:** A method of measuring the strength of a motive\* by observing the efficiency of an organism as it tries to overcome obstacles to the achievement of a goal.

**Occipital lobe:** The posterior\* portion of the cerebrum.

**Oedipus complex:** In Freudian theory, a libidinous love of son for mother, accompanied by hatred of father.

**Olfactory area:** Region on the lower infolded area of the temporal lobe, known as the *hippocampus*.

**Olfactory lobe:** Protuberance on lower surface of the cerebrum\* over the nose; pathway of smell impulses.

**Olfactory organ:** Special endings, in the membrane of the upper nasal cavity, that initiate impulses of smell.

**Ontogenetic:** Relating to the genesis and growth of organisms.

**Optic chiasma:** The X-shaped crossing of the optic nerve on the under surface of the frontal\* lobes of the cerebrum\*.

**Optimal intelligence score:** That score, on an intelligence\* test, which is regarded as indicating the intelligence level best suited to the requirements of a job.

**Ordinate:** See *y-axis*.

**Organ of Corti:** Structures in cochlea\* of the inner ear where sound vibrations excite nerve\* impulses.

**Organic psychosis:** Any form of insanity\* caused by deterioration in the tissue of the brain\*.

**Organismic:** An explanation of behavior\*, based on a reference to the unity of the whole individual as opposed to reaction of parts. See *Gestalt psychology*, *Koffka*, *Wertheimer*.

- Orientation:** Knowledge by a patient of his place in space or time and of his social relations.
- Orientation, sense of:** Applied to the vestibular sense which responds to movements of the body, or to rotation.
- Ossicles:** Literally small bones, applied specifically to the hammer, stirrup, and anvil in the middle ear.
- Ostrich complex:** Imitation of the behavior of the ostrich by ignoring a difficulty. (The ostrich is supposed to hide from danger by putting his head into the sand.)
- Oval window:** Opening in the bone between the middle and inner ear into which the foot of the stirrup fits and in which it is held by a delicate membrane.
- Overcompensate:** To exaggerate a trait considered socially desirable, in order to cover up imagined or real deficiencies. See *compensation*.
- Overt:** Open, not concealed. See *covert*.
- Overtones:** Partial tones produced in a string or other sounding body by vibrations of fractions of its length. These are in addition to the vibration of the whole that gives the *fundamental*. See *difference tone*.
- Ovum:** The female germ cell.
- Paedology:** The study of the characteristics and behavior of children. See *pediatrics*.
- Paramnesia:** A defect of memory\*, which causes the individual to recall events incorrectly or to associate them with incorrect items.
- Paranoia:** A form of psychosis\* marked by well developed consistent delusions\*. The patient shows few other symptoms of deterioration. See *insanity, pathology*.
- Parasympathetic nervous system:** The cranial\* and sacral\* portions of the autonomic\* nervous system. The two extremes of the autonomic nervous system, which act as a check on the sympathetic system.
- Parathyroids:** Four bodies located next to the thyroid\* gland which serve as a check against the thyroid and appear to influence one's supply of calcium.
- Paresis:** A form of insanity\* due to recurrent or delayed results of syphilitic infection. The symptoms are marked delusions\*, increasing spread of paralysis and, unless treated by induced fever, death a year or so after onset.

**Parietal lobe:** The portion of the cerebrum\* back of the central fissure\*, above the Sylvian fissure, and in front of the occipital\* lobe. In general, the upper central portion of the cerebrum. See *frontal lobes*.

**Parsimony:** The principle that the interpretation of data should be based upon the simplest acceptable explanation. Also called *Occam's razor*. See *Morgan's canon*.

**Pathology:** The study of abnormal behavior and of the diseased conditions of the organism that cause such behavior. See *feeble-mindedness*, *dementia praecox*, *hallucination*, *manic-depressive*, *chorea*, *paranoia*.

**Pediatrics:** Medical science dealing with children's diseases. See *paedology*.

**Pedology:** See *paedology*, *pediatrics*.

**Percentile:** A grouped series of scores may be divided into one hundred equal parts. The point setting off each of these parts is a percentile. A percentile of 30 means that the case selected is at a point below which one finds 30 per cent of all the cases in the series.

**Percentile rank:** The relative position of a pupil in his group on the basis of the percentile\* location of his score in a distribution\*.

**Percept:** The object of perception\* or awareness. The things of which we are conscious\* as they appear in our experience.

**Perception:** Meaningful awareness of stimuli or ideas.

**Performance test:** A test which measures one's ability by requiring the performance of a task without the use of language.

**Peripheral system:** The system of spinal nerves which send afferent\* messages to the brain or spinal cord from sense organs located below the neck region, and efferent nerves to the muscles.

**Personal equation:** Individual characteristics of an investigator which cause him to arrive at somewhat different findings from those of other investigators. Thus, the fact that one observer reacts more quickly than another may result in differing interpretations or measurements of phenomena.

**Personality:** The integrated organization of an individual's reaction tendencies. The sum of traits\* which affect one's behavior.

**Personality schedule:** A test devised by Thurstone\* in 1929 for measuring emotional stability.



- Personality tests:** Tests designed to measure traits of personality\*, such as emotional stability, emotional maturity, ascendance\* or submissiveness, masculinity, etc.
- Phantasy:** The process whereby one's imagination wanders away from reality to a considerable extent, and one indulges in pleasing imagery. Day dreaming.
- Philosophy:** The study of the world of man and nature; in the broadest sense, includes analysis of the presuppositions of science\*. See *logic, epistemology*.
- Phi phenomenon:** Apparent movement produced by the rapid exposure of lines which are really stationary.
- Phobia:** An exaggerated fear. A morbid fear. See *claustrophobia, agoraphobia, acrophobia*.
- Physiogenic:** Developed in the physical structure rather than in the mind of the individual.
- Physiological limit:** The limit placed upon the individual's ability to perform by the limitations of his physical equipment.
- Physiological motive:** Behavior drives\* aroused chiefly by persistent stimuli of internal origin. Such motives include those of hunger, sex, thirst, etc.
- Physiological psychology:** That division or branch of psychology\* which investigates relations between the mechanics of structure and functions of the human organism.
- Physiology:** The scientific study of the mechanics of structure as related to function.
- Pineal gland:** An endocrine\* gland in the brain\*. It is believed that this gland arrests the development of sexual characteristics up to the age of puberty\*. See *pituitary gland*.
- Pituitary gland:** An endocrine\* gland at the base of the brain\*. The anterior\* part of the gland affects growth and sex activity; and inactivity of the posterior\* part also interferes with physical and mental development.
- Plateau:** Name given to a period during which no progress is made in the acquisition of skill.
- Play:** Activities performed because of intrinsic interest\* in the activities.
- Plethysmograph:** Apparatus that records changes in the volume of a member or organ.

- Pluralism:** The theory that reality is made up of more than one directive entity or agent. See *monism*.
- Pneumograph:** An instrument that records breathing movements.
- Poggendorf illusion:** An illusion\* wherein small angles are overestimated and larger ones are underestimated.
- Point scale:** A system that measures capacity in relation to percentile\* standing in a group. See *age-scale, norm*.
- Polarity, principle of:** The principle that the nerve impulse passes from dendrites\* through the cell-body\* to the axone\* of a neurone\*, and thence over a synapse\* to the dendrites of a second neurone. One-way conduction of the neural impulse.
- Pollyanna attitude\*:** An exaggerated optimism which places the best possible light on whatever happens.
- Pons:** A structure on the anterior surface of the brain stem at the level of the cerebellum. It contains nuclei connected with the vestibule of the ears and with the cerebellum.
- Porteus maze:** A maze\* in which the subject must indicate the open path with a pencil. Used as a test of intelligence\*.
- Positive transfer:** See *transfer*.
- Posterior lobe:** One of the two lobes of the pituitary\* gland, located toward the back part of the gland. Undersecretion in the posterior lobe is supposed to cause obesity.
- Post-hypnotic suggestion:** A suggestion given, during hypnosis\*, of acts that are to be executed after waking.
- Power test:** A test of knowledge or ability, without definite time limits. See *speed test*.
- Practice curve:** Graph\* made by indicating successive scores made during the acquisition of an act of skill.
- Praise:** Approval of responses which serves to stimulate further effort. Praise is a more effective form of motivation\*, in most cases, than blame or reproof\*.
- Prediction:** Prognosis\*. The foretelling of the future behavior of an individual or group. The discovery of a principle or law of science makes it possible to predict what will happen under stated environmental circumstances. See *prognostic test*.
- Prepotent reflex:** Inherited tendencies to act that show themselves only by hastening the learning of the act.

- Primary memory:** Retention\* of an experience after a single repetition, usually measured immediately.
- Primary sex characteristics:** The reproductive sex qualities of the individual.
- Probability curve:** A graphic representation of the distribution of chance errors and also of various mental and physical measurements of the population as a whole.
- Process, mental:** Any event in consciousness.
- Profile:** See *psychograph*.
- Prognosis:** Originally, forecasting the course of a disease from its symptoms. Extended to include forecasting in any human relation.
- Prognostic test:** An aptitude\* test; used to predict extent of a pupil's future achievement. See *prediction, diagnostic test*.
- Projection:** Ascribing one's own failures or shortcomings to others.
- Projection areas:** Sensory and motor\* areas in the cortex\*. (Sherrington\*).
- Projection fibers:** Fibers connecting sense\* organs and muscles with projection\* areas.
- Prompting method:** The method of measuring a subject's memory\* for a selection by the number of promptings he needs before he can repeat it.
- Proof:** The process of creating belief\* by means of evidence and reasoning\*. Proof may be deductive or inductive.
- Propaganda:** Forms of suggestion whereby people are taught to accept a particular approach to the solution of social and economic problems. More broadly, any deliberate means of inducing others to adopt a principle or doctrine. See *belief, attitude, suggestibility*.
- Proprioceptors:** Sense\* organs, in tissues, that are stimulated by changes in tissues, as the kinaesthetic\* sense organs in the muscles. See *exteroceptor*.
- Protanopia:** Colorblindness\* in which the long wave lengths appear darker than the short wave lengths, and darker than for the normal individual.
- Proximity:** A Gestalt\* law which states that in perception the lines or figures that are close together are more likely to be seen as a unitary group than are the more distant ones.
- Pseudophone:** Instrument with tubes leading from horn in front of one ear to ear on opposite side. Reverses direction of tones\*.

**Pseudoscope:** Instrument, with prisms (or mirrors) adjusted to reverse the double images. The result is that nearer objects appear farther away than more distant objects, and distant objects appear to be close at hand.

**Psychasthenia:** Janet's\* term for a neurosis\* marked by fixed\* ideas, false recognition, and weakening of decision.

**Psyche:** Greek word for *mind*.

**Psychiatrist:** Physician who specializes in mental diseases.

**Psychiatry:** The systematic study of mental illnesses. See *pathology*.

**Psychoanalysis:** The method, developed by Freud\*, for discovering events in the unconscious\* by means of repeated questioning.

**Psychogalvanic reaction (PGR):** Change in the conductivity or electropotential of the skin as a result of emotion\* or effort\*, probably due to moistening of the skin by the sweat glands. See *galvanic skin-reflex*.

**Psychogenic:** Developed in the mind, rather than in the physical structure of the individual.

**Psychograph:** Curve that shows for a given individual his measurements in tests and in school to give a picture of his ability\*.

**Psychology:** The sum of the facts and theories of the mental life of man and of his behavior in the broadest sense. The science that studies the reactions of organisms to environmental stimuli. So conceived, psychology is both a biological and a social science. Its aims are understanding, knowledge, prediction, and control. Its branches are: abnormal; adolescent; applied; child; comparative; educational; experimental; race; social; and general. Its methods are indicated by the terms: experimental\*; genetic\*; case history\*; by-product\*; and correlation\*. See *scientific method*.

**Psychometrics:** The science of measuring mental processes.

**Psychoneurosis:** Minor disorder in behavior patterns; minor abnormality\*. See *neurosis*.

**Psychoneurotic inventory:** Questionnaire\* to bring out psychotic\* and neurotic\* defects. Best known prepared by Woodworth\* in 1918.

**Psychopathic:** Pertaining to mental illness and abnormal behavior. See *pathology*.

**Psychophysics:** Fechner's\* term for the science\* that relates physical to

mental processes. A major outcome was Weber-Fechner Law (1860).

**Psychosis:** A serious form of mental disease. Technical term for insanity\*.

**Psychotherapy:** Treating diseases by mental means.

**Psychotic:** Suffering from a mental disease.

**Puberty:** The age period of very rapid sexual maturation, during which the individual becomes able to have offspring. Generally begins at eleven or twelve years, with girls, and thirteen or fourteen years, with boys. See *childhood*, *maturity*.

**Pupillary reflex:** Change in the size of the pupil induced by change in the intensity of light or by adjustments of accommodation\*.

**Purkinje phenomenon:** Decrease in the apparent brightness of long waves of light when there is reduced illumination, as in twilight\* vision.

**Purposive behavior:** Reactions which are motivated by an incentive or result anticipated by the subject. In a purposeful act, the individual is aware of his motive and knows the means of satisfaction.

**Pyknic type:** Kretschmer's\* term for individuals who have narrow shoulders, wide hips and surplus adipose tissue. See *cyclothyme*.

**Pyramidal tract:** Connective fibers from the cortex\* to the brain\* stem.

**Quartile:** One-fourth of the cases of measured characteristics. If one arranges scores in a series, in order of size, the upper quartile will constitute the upper fourth, the lowest quartile, the lowest fourth of all the cases. See *median*, *percentile*.

**Questionnaire:** A series of questions designed to disclose facts concerning groups. Used in personality\* studies.

**r:** The symbol for correlation\* coefficient\*.

**Random sampling:** A number of cases representative of larger groups of cases. The representative or sample cases are selected on the basis of random choice.

**Range:** The difference between the lowest and the highest scores in a distribution.

**Rank:** A pupil's standing as judged by his relative position when



compared with other pupils in a group. The place of any datum when compared with other data in a distribution.

**Rating scale:** A series of items or qualities arranged to indicate the order of merit (in some characteristic) so that an individual may be compared with others. These scales have been developed for measuring executive ability and for handwriting.

**Rationalization:** The process of finding an excuse for an emotionally determined decision. See *adjustment mechanism*.

**Raw score:** The crude score on a test; generally, the sum of the points or credits allowed for the pupil's correct answers.

**Reaction:** A movement produced by sensory stimulation.

**Reaction hypothesis:** The theory that all behavior occurs as reactions to stimuli.

**Reaction time:** The interval between stimulus\* and response.

**Readiness, law of:** The principle that when a conduction unit is ready to act, its action is satisfying; if it does not act, its failure to do so is annoying; and its action is also annoying if it acts before the individual is ready. See *exercise, effect*.

**Reality, flight from:** A symptom of certain nervous diseases that leads the individual to avoid life's difficulties. Day dreaming is a frequent one, hysterical blindness another.

**Reasoning:** Reaching conclusions not contained in direct experience. Involves problem solving and proof\*.

**Recall:** The process of reviving old experiences. See *amnesia, retention, recognition, reminiscence*.

**Recency, law of:** The principle that the recall\* of more recent experiences is more probable than recall of less recent ones.

**Receptor:** A sense\* organ or the sensitive cells of a sense organ. See *effector*.

**Reciprocal inhibition:** A mutual interference in functioning between two nerve centers or mental processes. See *inhibition*.

**Reciprocal innervation\*:** The contrasting action of two motor centers so that the movement of one muscle is counterbalanced by that of another. Thus, one muscle may contract while another relaxes.

**Recognition:** Appreciation of an object or idea as having been experienced before. The object appears familiar. See *memory, recall, association, reduced cue, retention*.

- Reconditioning:** A method of controlling or eliminating undesired responses by retraining in which the subject associates stimuli repeatedly with pleasant experiences.
- Reconstruction method:** A method of testing memory by asking the subject to arrange a series of syllables or objects in the order in which they were originally given.
- Redintegration:** The theory that all recall\* consists in having one element revive the whole of which it was previously a part.
- Reduced cue:** A secondary stimulus or experience which, by means of association\*, serves as the basis for the recall\* of past experiences. See *belongingness, engram*.
- Reflex:** Simple response to a stimulus\*. Examples are the wink reflex, patellar reflex, and other apparently unlearned responses to stimuli.
- Reflex arc:** Term used by Dewey\* to indicate that stimulus\*, response, and awareness of the response are all parts of a unit.
- Refractory period:** The period of time after the passage of an impulse along a nerve\* during which no other impulse can be aroused.
- Regress:** To revert to childish modes of response in order to escape a difficulty or achieve an end. See *adjustment mechanism*.
- Regression:** The tendency of neurotics\* to seek refuge in childish responses. One of the escape\* mechanisms.
- Regressive movements:** Movements of the eye of a reader when he goes back to a word he has missed.
- Relearning method:** Method of measuring the amount of subject matter a learner retains, by finding the number of repetitions he requires to relearn the material.
- Reliability:** The self-consistency of a test. Measured by correlating\* the scores on odd and on even numbered questions with each other; also measured by correlating the scores on two forms of a test, or the scores earned on two administrations of a test. See *validity*.
- Reliable:** See *reliability*.
- Reminiscence:** Tendency of some memory\* traces to grow stronger with time. See *oblivescence, recall, retention*.
- Remote sensations:** Sensations of sight, hearing, and the like, which control movement.
- Repress:** To force out of consciousness\* unpleasant or painful ideas\*, in order to escape the necessity of facing a conflict\* or difficulty.

**Repression:** The checking of unpleasant or undesirable experiences and ideas so that, according to the psycho-analyst\*, such elements are forced down into the subconscious\*. Unconscious forgetting. See *sublimation*.

**Reproduction:** Recall\* of material previously learned.

**Reproof:** Adverse criticism of an individual's responses. Reproof is a less effective form of motivation\* than praise, but is more effective than completely ignoring the individual. See *praise*.

**Resident sensations:** Kinaesthetic\* sensations from the muscles of a moving part of the body also control the contractions of the muscles. These sensations are called resident sensations by William James.\*

**Resistance hypothesis:** The theory that learning consists in reducing the resistance at the synapse\* to the passage of the nerve impulse.

**Retention:** Keeping a trace of an experience in the cortex so that the experience is subject to recall\*.

**Retina:** The innermost layer of the eye, the layer that is sensitive to light.

**Retinal rivalry:** The alternate appearance and disappearance of incompatible images that fall on corresponding\* points of the two retinas\*.

**Retroactive inhibition:** The fact that the trace\* left by learning a selection is interfered with if other material, particularly similar material, is learned after the first selection. See *inhibition*.

**Retrograde amnesia:** Fact that a physical or mental shock prevents the recall\* of events that preceded the shock.

**Revesz illusion:** An illusion\* wherein two identical figures are so placed with respect to each other that they no longer appear to be identical. Because of their surroundings, one of the two figures will appear to be larger than the other.

**Rhodopsin:** The visual\* purple in the rods\* that sensitizes the eye to faint lights.

**Rhythm:** Grouping of successive sensations\* into units, with regular accents on certain parts or elements of the units.

**Right and wrong cases, method of:** Measures a limen\* by giving repeatedly two sensations\* of a constant difference in intensity and asking the subject to say which is more intense. Limen may be calculated statistically from the difference between the stimuli applied and the proportion of the statements that are correct.

**Rorschach test:** See *ink-blot test*.

**Round window:** Membrane between the middle and the inner ear that permits the liquid of the inner ear to vibrate with the sound.

**Saccadic:** The rapid direct movement of the eyes, as in surveying an object or in reading.

**Sacral division:** One of the three parts of the autonomic\* nervous system. The other two parts are the cranial\* and the thoraco-lumbar (sympathetic\*). The sacral division transmits impulses to the colon, rectum, bladder, and external genitals.

**Sadism:** Satisfaction, akin to sexual gratification, as a result of seeing the suffering of another individual.

**Saturation:** A color that contains the least brightness and most color possible. Color purity.

**Savings method:** See *relearning method*.

**Scatter:** The dispersion or extent of departure of scores from their central\* tendency. Three measures of scatter are: the range\*, the average\* deviation, and the standard\* deviation.

**Schizoid (schizophrenic):** An individual with some of the characteristics of schizophrenia\*, but not necessarily insane.

**Schizophrenia:** A mental disease characterized by mental deterioration, delusions\*, and blunting of the emotions\*. See *dissociation*.

**Schizothymes:** Quiet, reserved individuals of the introspective type, according to Kretschmer's\* classification. Normals with some traits of schizophrenia. There is an increasing order of severity in the symptoms from schizothyme to schizoid and schizophrenic, according to Kretschmer.

**Science:** A systematic array of facts and principles, organized as a body of knowledge about some large area of nature. The chief content of a science are verifiable facts and laws.

**Scientific method:** A method of obtaining the data of science\* by definite controlled procedures. In this method, problems are defined, events and relationships carefully observed and classified, theories formulated and tested by experiment\* and observation, and verifiable principles established.

**Scotoma:** An area in the retina\* insensitive to light; usually the result of deterioration.

**Scotopic vision:** Twilight vision.

**S. D.:** Abbreviation for standard\* deviation.

**Secondary sex characteristics:** Body form, body hair, pitch and quality of the voice, and other subordinate indications of sex.

**Seguin Form Board Examination:** An intelligence\* test of the performance\* type, in which the person being tested is required to fit wooden units into their proper spaces on a board.

**Self:** For older writers and in popular belief, the directing force in the individual, but for modern psychology the sum of a man's capacities\*.

**Semi-circular canals:** Three semi-circular tubes in the vestibule of the ear, arranged at right angles. They are filled with liquid and at one end of each are hairs that stimulate a branch of the eighth nerve\* as the head rotates. See *equilibrium*.

**Senile psychosis:** Abnormal mental reactions caused by the physiological changes of old age.

**Sensation:** Awareness of the response of a sense organ.

**Sense datum:** The immediate contributions of the senses, regarded as the foundation of knowledge.

**Sense organs:** Organs which react to stimuli and contain the various sensory receptors\*.

**Sensori-motor:** An action preceded by a sensation\* rather than by an idea\* is a sensori-motor action.

**Sensori-motor arc:** Chain of sensory and motor neurones\*, connecting a sense\* organ with a muscle or group of muscles.

**Sensory area:** Area in the cortex\* that receives impulses from a sense\* organ.

**Sensory generalization:** The elicitation of a conditioned\* response by stimuli that are similar to the stimulus\* originally associated with the response. The effectiveness of one stimulus spreads to other similar stimuli.

**Sentiment:** An emotional feeling about anything; a thought or opinion based upon an emotional set.

**Set:** An adjustment of the organism whereby it favors the reception of one sensation\*, or range of objects, or makes a particular movement or group of movements.

**Sex:** General name for the emotions\* and acts that lead to the propagation of progeny. Much emphasized in psychology by Freudians. See *Freud*.



**Sex complex:** A group of ideas\*, usually in the unconscious\*, that have a sexual reference.

**Sheath of Schwann:** See *neurilemma*.

**Sibling:** One of two or more brothers and sisters.

**Sight:** See *vision*.

**Sigma ( $\sigma$ ):** Greek letter used as a symbol for standard deviation and also to indicate a thousandth of a second.

**Sign learning:** The anticipation of consequences by a subject who reacts adaptively on the basis of previous trials or experiences. The principle of expectancy, modifying Thorndike's law of effect, recognizes that annoyers are not always necessary to eliminate incorrect responses. The subject may anticipate annoyance and adapt his reactions accordingly.

**Similarity:** A Gestalt\* law which states that it is easier to perceive as a group the stimuli that are alike than the ones that are dissimilar.

**Similarity association:** The recall\* of one idea\* by a like idea.

**Simultaneous conditioning:** Conditioning\* in which the natural and the substitute stimuli\* are presented simultaneously or almost simultaneously.

**Skewness:** A curve of distribution\* of data that is asymmetrical, usually because samples have been taken from a restricted group. See *bell-shaped curve*, *normal distribution*, *Gaussian curve*.

**Smell:** See *olfactory lobe*, *olfactory organ*.

**Smooth muscle:** A muscle that does not show striations. As a rule these muscles are in organs of vital functions: viscera\*, blood vessels, etc., and are supplied by nerves\* of the autonomic\* nervous system.

**Social intelligence:** See *intelligence*.

**Sociality:** The extent to which the individual conforms to the laws and customs of his society.

**Social psychology:** That branch of psychology which studies the behavior of individuals in their group associations.

**Sociology:** The science which studies group life, the relationships among men, and the institutions and problems of society.

**Somesthetic:** Sensations\* arising from the body tissues.

**Soul:** Once assumed to be a force controlling the behavior of man. Still used popularly in that sense, but relatively seldom by modern psychologists.

**Space:** The concept\* that includes extension, position, and the three dimensions.

**Space perception:** Appreciation of spatial aspects of objects.

**Span, memory:** The number of objects that may be recalled after one repetition or a single exposure.

**Span of attention:** The number of objects that may be perceived in a short exposure, usually taken at about 1/5 second.

**Specific energy, doctrine of:** The notion that a sense\* organ can give but one sense quality; that the quality is determined by the organ.

**Speech center:** An area in the cortex\* associated with oral expression.

**Speed test:** A test of knowledge or ability, in which the person being tested must complete his work within definite time limits. See *power test*.

**Sperm:** The male germ cell.

**Sphygmograph:** Instrument used to measure pulse rate.

**Sphygmomanometer:** Instrument used to measure blood pressure.

**Spinal cord:** The nerve\* tissue in the spinal column. It is composed of a central mass of cell-bodies\* and a surrounding series of columns of axones\*. It is the locus for simple reflexes\* and a path for impulses from skin to cortex and cortex to muscles of trunk and limbs.

**Spirit:** Sometimes used as equivalent of mind or soul.

**Spontaneous recovery:** The process whereby, after a conditioned\* response has been inhibited, it is later re-elicited or evoked upon the presentation once more of the conditioned\* stimulus.

**Standard deviation:** The square root of the mean of the squares of all deviations\* of a set of measures from their arithmetic\* mean.

**Standard error:** The error (of estimate or measurement) calculated by application of the standard\* deviation.

**Standard score:** The number of standard units of a score, above or below the arithmetic mean of a distribution of scores. The distance (in terms of standard deviation) of a pupil's score from the mean average of a group of scores.

**Standardized test:** A test in which the questions are of an objective character, and for which standards (norms\*) of achievement have been determined on the basis of the scores earned by many pupils.

**Stanford-Binet scale:** An adaptation by Terman\*, of Leland Stanford University, of Binet's\* intelligence\* test.

**Statistical:** Derived from the science\* of statistics\*.

**Statistics:** A division of mathematics, which develops and applies various methods of organizing and interpreting numerical data.

**Stereoscope:** An instrument, using mirrors or prisms, to combine two pictures, each seen with a single eye, into a single impression.

**Stereotyped attitude:** A relatively fixed mental set or disposition to react in a definite way to a situation or issue.

**Stimulus:** Any energy that can affect a sense\* organ.

**Stimulus-response theory:** A school of psychology\* that emphasizes the importance of the reactions upon excitations of the senses. The theory accepts the response as part of the general system of the organism, but is not content to forego analysis altogether. See *atomism*.

**Strabismus:** A condition of crossed eyes, due to lack of co-ordinated muscular control or to other defects of eye muscles.

**Striated:** Formed with fine thread-like lines, characteristic of voluntary muscles.

**Structural psychology:** The school of psychology\* that believes the science should analyze consciousness\* into simple elements. See *functional psychology, existential psychology, Gestalt*.

**Structuralist:** An adherent of the school of structural\* psychology.

**Subconscious:** Processes assumed to modify consciousness\* or behavior, although the individual is not aware of the processes themselves.

**Subject:** Name given an individual (or animal) who is investigated or who performs in a psychological experiment\*.

**Sublimation:** A phase of Freud's\* cure that consists in changing an unconscious drive into a conscious one that is socially approved. A sex drive may be replaced by charitable acts or work with benevolent organizations. See *catharsis*.

**Subliminal:** A stimulus\* too faint to be noticed (under the limen\*).

**Submission:** Timidity and the habit of following others in situations calling for decision and action.

**Subnormal:** Below normal\*.

**Substitution:** In a dream, the replacing of an individual really meant by another. According to Freud\* it is a device used by the unconscious\* to conceal the real meaning from the censor\*.

**Succession:** A law of learning\* (formulated by Aristotle\*) which states that learning takes place when items are seen to follow each other in a particular order (as in the alphabet). See *contiguity*, *law of*; *association*; *contrast*.

**Suggestibility:** Ease with which an individual can be influenced by the remarks or requests of others.

**Summation:** The process whereby the combined action of two or more stimuli evoke a more prompt or a more vigorous response than one of the stimuli acting by itself.

**Summation tone:** Tone\*, equal to the sum of the vibration rates, that is produced when two tones are sounded together.

**Superconsciousness:** See *super-ego*.

**Super-Ego:** The human conscience. The habitual traits developed by the individual in accordance with the customs and requirements of society. Freudian term.

**Superiority complex:** Exaggerated feeling of self-assurance, leading the individual frequently to neurotic self-expression.

**Supernormal:** Above normal\*.

**Suppression:** Conscious effort to forget.

**Supraliminal:** Stimulus that produces a sensation\* (above the limen\*).

**Suprarenal:** Adrenal\*, endocrine\* gland above the kidney.

**Syllogism:** The association of a new suggestion with older organized knowledge, so that a conclusion is arrived at which is supported by reasoning from given facts or premises. The syllogism consists of a major premise stating a general principle; a minor premise relating the conclusion to the major premise; and the conclusion.

**Symmetrical curve:** See *bell-shaped curve*.

**Sympathetic nervous system:** Series of ganglia\* found in the abdominal cavity near the spinal column. They receive impulses from the spinal\* cord and transmit them to the viscera\*, glands\*, blood vessels, etc. The middle portion of the autonomic\* nervous system.

**Sympathism:** The extending of pity or sympathy\* by one's friends when one is faced with a difficulty or conflict\*.

**Sympathy:** Literally suffering with another. Used for the immediate sharing of pleasures and pain of others. Made by some the fundamental response in social co-operation.

**Synaesthesia:** Tendency present in certain individuals for connecting

sensations\* from different senses. E.g., the month of March is always seen or thought of as blue.

**Synapse:** Place of contact between the end brush\* and dendrites\* of two neurones\*. See *nerve*.

**Tabes:** See *locomotor ataxia*.

**Tachistoscope:** An instrument to give a brief exposure of cards or objects.

**Tactile circle:** Circle on the skin, within which two points seem to be one point.

**Task:** An assignment, or unit of work, that has been set or chosen.

**Taste:** See *gustation*.

**Taste buds:** Primary organs of taste in papillae on tongue.

**Tectorial membrane:** Membrane in cochlea\* of the ear that lies over the hair cells on the basilar\* membrane.

**Teleology:** Belief that an end or purpose controls the behavior of individuals and the events of the universe.

**Telepathy:** Assumed transmission of thought without use of movement or of the senses. See *clairvoyance*.

**Temperament:** Relatively permanent tendency of an individual to respond emotionally in a characteristic way.

**Temporal lobes:** Parts of the cerebrum\* below the *Fissure of Sylvius*. See *parietal*, *frontal*, *occipital*.

**Thalamus:** Structures in the tween-brain on either side of the third ventricle. Mediates sensory paths to the cortex\* and is a center for certain automatic controls.

**Thoraco-lumbar:** The nerve fibers arising from the middle portion of the spinal\* cord. The sympathetic\* nervous system.

**Threshold:** Intensity at which a stimulus\* just produces a sensation\*. Same as *limen*\*. See *absolute limen*.

**Thymus:** An endocrine gland in the lower section of the neck. Has some control over the growth of sex glands. Atrophies at puberty.

**Thyroid gland:** Endocrine\* gland, located in the throat. Secretes a hormone\* that is essential to physical and mental development. A defective thyroid causes cretinism\*, a form of feeble-mindedness\*, accompanied by dwarfism\*. See *thyroxin*, *myxoedema*, *ductless glands*.

**Thyroxin:** The secretion of the thyroid\* gland.



- Timbre:** The quality of tones\* that varies with the overtones\*; it differs for musical instruments and for vowels.
- Time reflex:** A type of reaction in which when the unconditioned\* stimulus is presented at regular intervals for a time, and is then omitted, a conditioned\* response occurs anyway, at approximately the usual time.
- Tone:** Sensation\* caused by vibrations of the air at a constant rate.
- Tone, muscular:** Slight muscular contractions that maintain the position of the body or of a limb.
- Topology:** A modern school in psychology that explains mental life by the analogy of forces in a space that can be defined but not measured. See *Lewin*.
- Trace:** See *engram*.
- Trace reflex:** A type of reaction in which when the conditioned\* stimulus is presented and is then followed by a brief pause prior to the unconditioned\* stimulus, the conditioned\* response appears at the end of the pause.
- Training method:** A method of studying growth\*, which analyzes the effects of practice (training) on the development of behavior patterns.
- Trait:** A standard way of responding to similar situations.
- Transfer:** The improvement in one function by practice of another function. Learning one poem improves the ability to learn another poem. Here we have *positive transfer*. In some cases practice of one function impairs another. Playing golf is said to decrease skill in baseball. This is *negative transfer*. *Zero transfer* means no improvement and no interference. See *identical elements*, *Thorndike*, *Judd*.
- Trial-and-error learning:** The process of learning\* by making chance movements until one happens to succeed, and then repeating the successful movement until it is fixed, and can be made at will.
- Trichromat:** An individual who possesses normal\* vision. Given the name because every person with normal vision was assumed by Helmholtz\* to have the three primary color organs.
- T-type:** The classification by Jaensch\* of children who have little or no control over their eidetic\* images.
- Twilight vision:** See *scotopic vision*.
- Tympanum:** The ear drum.

**Type:** Objects, individuals or qualities characterized by standard sets of attributes.

**Unconditioned stimulus:** Any stimulus\* that is of itself adequate enough to produce a response. A stimulus that is not dependent upon association with other stimuli for its results. See *conditioned stimulus*.

**Unconscious:** (1) lacking awareness; (2) term used by Freud\* and others to designate memories\* which have been conscious and which continue still to persist despite the fact that the individual is not directly aware of them. These memories are assumed to be responsible for disease symptoms. See *psychoanalysis, subconscious*.

**Unconscious motivation:** Motivation\* in which one is not aware of the energizing factors that direct one's reactions. An incentive\* may lead us to act without our being conscious of the effect of the incentive.

**Use, law of:** See *exercise, law of*.

**Utricle:** Large sac in the vestibule\* of the ear from which the semi-circular\* canals extend.

**Valid:** See *validity*.

**Validity:** Agreement between the results of a test and the performances which the test has been constructed to measure. See *reliability*.

**Variability:** Divergence of measurements from each other or from the mean\* of a distribution\*. The extent to which individuals diverge from each other in traits or abilities. See *deviation*.

**Variable:** A characteristic or item which varies in quantity or effect.

**Verbal imagery:** Imagery\* used for the recall\* of words. Images in the form of words. Verbal images may be auditory, visual, or even kinesthetic\*.

**Verbal intelligence:** See *intelligence*.

**Verbal learning:** Learning\* by means of the use of language. Also, the process of learning to use words and other symbols of language.

**Verbal test:** A test which calls for the use of oral or written language by the person taking the test. See *performance test*.

**Vestibule of the ear:** Cavities near the oval\* window of the ear, that give rise to movements of orientation\*.

**Virilism:** Masculine qualities such as the beard or the development of a large muscular body.

**Viscera:** The large organs of the abdominal cavity.

**Visile:** An individual who recalls largely in terms of sight.

**Vision:** The sense for which the eye is the organ that receives the stimuli. Monocular vision is sight with the use of a single eye; binocular vision is sight with the use of both eyes. The fovea\* is the region of direct vision and the center of fixation. See also *convergence*, *accommodation*, *myopia*, *hyperopia*, *blindness*, *color-blindness*.

**Visual area:** Area, on the median surface of the occipital\* lobe, which receives the impulses from the eye.

**Visual purple:** A chemical substance, found in the outer layer of the rods\* that sensitizes the eye to faint lights.

**Vital organs:** Those parts of the body which are essential to life, e.g., the heart, lungs, adrenal glands, spleen.

**Vividness:** The lifelike, brilliant quality of experience; the intensity of a perception or idea.

**Volition:** A technical term for the will\*.

**Volley principle:** Suggestion of Wever and Bray that the auditory nerve may act on a stagger principle, each fiber starting its electrical impulse later than another fiber, and may thus permit the transmission of high frequencies although each fiber is limited to 300 waves per second.

**Voluntary action:** Action that is controlled by intention and is fully conscious\* in its execution.

**Warm spot:** Spot on the skin that gives rise to a sensation\* of warmth when stimulated.

**Weber's Law:** Statement that a difference between two stimuli\* can be appreciated when one stimulus is a certain fraction more intense than the other.

**Weber-Fechner Law:** Principle formulated by Fechner (1860) on the basis of his psychophysical studies pertaining to the relationship between stimulus intensity and magnitude of sensation. The law states that as the physical intensity increases by constant ratio (Weber's Law), the magnitudes of the sensations increase by equal

increments. Known today to hold only to a first approximation within the middle range of human sensitivity. The law makes the relationship between stimulus and sensation intensities logarithmic in nature.

**White matter:** Bundles of axones in certain portions of the spinal cord and brain, coated with a white, fatty sheath or covering (myelin).

**Will:** Sum of the factors that control an individual's reactions.

**Will-to-power:** The single force, within the individual, postulated by Alfred Adler\* as directing and sustaining man's responses toward the achievement of superiority and power.

**Wish-fulfillment:** A theory of Freud\* that dreams represent the elaboration of ways of attaining desires.

**Worry:** A subacute form of fear\*. In some cases, closely related to adjustment by surrender. See *anxiety*.

**X-axis:** The base line of a chart or curve.

**y-axis:** The vertical distance of a curve, representing the number of cases, whereas the x-axis indicates the size of each score or other measure. The ordinate.

**Yellow spot (macula lutea):** A small area in the center of the retina\* about the fovea\*, so-called because of yellow pigment present.

**Zero coefficient:** The zero figure used to indicate complete lack of relationship (correlation\*) between scores or other variables\*.

**Zero transfer:** See *transfer*.

**Zöllner illusion:** An illusion\* in which a series of parallel lines no longer seem to be parallel when short oblique lines are drawn across them.





PART THREE

*Contributors to Psychology*

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## PART THREE

### *Contributors to Psychology.*

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IN THIS section are listed and discussed the contributors of numerous investigations in psychology and related disciplines. Only those contributors who are of particular significance for the student in introductory psychology have been included. For more detailed information on these or additional contributions, the student is referred to current texts which summarize the work of all investigators in this field. The student may also find the reading of current psychological journals informative and supplementary to the discussion in this section.

Unless otherwise indicated contributors to the science of psychology listed within this section are living.

NOTE: Terms followed by an asterisk are defined or discussed in Part II, the dictionary section. Names followed by an asterisk are discussed in this section (Part III).

Ach, N.: German psychologist who studied extensively the control of associations and the action or will processes. Best known for his theory that attitude\* or set is the most important determinant of mental life.

Adler, Alfred (1870-1937): Austrian psychoanalyst who held that all behavior\* is determined by the lust for power. Frustration\* of this drive leads to the development of the inferiority complex. His system of cure which he described in *The Practice and Theory of Individual Psychology* (1924) included methods by which patients were helped to overcome their difficulties and to achieve a feeling of superiority.

- Adrian, Edgar D.: English neurologist who has done much to investigate the electrical phase of neural conduction. With Keith Lucas he formulated the "all\* or none law." He published the *Basis of Sensation* (1928) and the *Mechanism of Nervous Action* (1932).
- Allport, Floyd H.: Studied motivation\* in relation to personality\*. With G. W. Allport he developed a test of aggressiveness and submission\*. Author of *Social Psychology* (1924).
- Allport, Gordon W.: Experimented with the problem of eidetic\* imagery, and developed a test of personality\* based upon Spranger's\* classification of values (with Vernon). Author of *Personality; A Psychological Interpretation* (1937).
- Angell, James R.: American psychologist who worked on reaction\* times and auditory localization\*. Best known for his advocacy of the School of Functionalism\* in psychology. Writer of several authoritative textbooks.
- Aristotle (384-322 B.C.): Greek philosopher and natural scientist, who wrote the first specifically psychological treatise. He developed the notion that the soul is the form of the body, at once its living principle, and, within limits, its directing agent. Developed the theory of associationism\*.
- Bain, Alexander (1818-1903): Scotch psychologist who was the first in Great Britain and among the first in psychology to study mental life in relation to physiology. He was also among the first to appreciate the importance of the evolutionary approach. His texts were standard from 1860-1890.
- Berger, Hans: A German neurologist who first studied the circulation of the brain\*. Best known today for his discovery of the electric waves, alpha\* and beta\*, which accompany neural action and periods of rest. The waves are sometimes designated, for these reasons, the Berger waves.
- Bergson, Henri (1860-1941): French philosopher who made incidental contributions to the theory of laughter and of the appreciation of time. His theory that human behavior\* is directed by a vital force called the *élan vital* is well known.
- Bernreuter, Robert G.: American psychologist known for the development and standardization\* of the "Personality\* Inventory" which

tests introversion-extroversion\*, ascendance\*-submission\*, and other traits\*.

Binet, Alfred (1857-1911): French psychologist, physiologist, and educator who developed the first thorough intelligence\* test of the age-scale\* type. Wrote extensively on hypnotism\*, pathological\* phenomena, intelligence\*, mental fatigue\*. He was the first French experimental psychologist.

Boring, Edward G.: An American psychologist, known for his research on sensations\* from the skin and internal organs, and for his work in space perception\*. Author of the *History of Experimental Psychology* (1929), and *Introduction to Psychology* (1939), the latter written by a number of authors and edited by Langfeld and Weld with Boring.

Braid, James (1795-1860): English physician who developed a scientific theory of hypnotism\*. Braid is generally credited with making hypnotism respectable.

Burt, Harold E.: American psychologist who has specialized mainly in animal\* and applied\* psychology. Author of *Legal Psychology* (1931).

Cannon, W. B.: American physiologist who investigated the physiological basis of emotions\* and of the inner reactions which accompany emotional experience. Modified the James-Lange\* theory of emotions by relating emotions to the hypothalamus\* rather than to the periphery\*. He showed the great importance of the secretion of the adrenal\* glands in emotion.

Carmichael, Leonard: American experimental psychologist who studies the development of behavior\* patterns in foetal animals. His experiments on the relationships between maturation\* and practice in the determination of locomotor\* responses in laboratory animals are well known.

Carr, Harvey A.: American experimental psychologist, who furthered the development of the Functional\* School. Author of *An Introduction to Space Perception* (1935). He emphasized sensory control in the selection and elimination processes in perceptual motor\* learning. His theory of sensory consequences to account for selection and elimination is well known.

Cattell, James McKeen: American psychologist who studied with

- Wundt\* and Galton\*. Was among the first to establish experimental work in America, especially to study individual\* differences and reaction times.
- Charcot, Jean (1825-1893): Well known French neurologist and psychologist who early recognized hysteria\* and used hypnotism\* in treatment. Influenced the later work of Janet\* and Freud\*.
- Coghill, G. E. (1872-1941): American anatomist who applied Gestalt\* theory to the explanation of parallel development of the nervous system and behavior of the larval amblystoma (species of salamander). He holds that mass movements appear first, and that single reflexes\* develop in subordination to the mass action of the whole embryo\*. This process he called individuation\*.
- Cole, L. E.: American psychologist who works with the construction of tests and in problems of space perception\*. Author of *General Psychology* (1939).
- Coover, J. E. (1872-1938): American psychologist who investigated many mystics. His findings in telepathy\* do not agree with the hypothesis\* of extra-sensory perception. Coover's *Experiments in Psychological Research* (1917) summarizes the modern position on the question of thought transmission.
- Culler, E. A.: An American psychologist who has investigated the problem of transfer\* of training and who is actively engaged in the study of the localization\* of tones in the cochlea\* of animals by means of the conditioned\* response technique.
- Darwin, Charles (1809-1882): English naturalist who won general acceptance by scientists for his theory of evolution. His theory was responsible for a complete change in the methods as well as in the underlying assumptions held by psychologists. His *Descent of Man* (1874), *The Origin of Species* (1859), and *The Expression of the Emotions in Man and Animals* (1872) contribute specifically to psychological problems as well as aiding in the development of a new point of view in the study of mental life.
- Dashiell, J. F.: American experimental and comparative psychologist who emphasizes the objective\* approach to the study of behavior. Author of the introductory texts entitled *Fundamentals of Objective Psychology* (1928), and *Fundamentals of General Psychology* (1937).



- Descartes, René (1596-1650): French mathematician and philosopher who believed in the innateness\* of fundamental ideas\* and the completely separate existence of mind and body, each acting according to its own laws. Founder of analytic geometry.
- Dewey, John: American philosopher who influenced psychology by his insistence on the functional approach and stimulated the development of the Functional\* School of Psychology. His *How We Think* (1910) led to experimental studies of the methods of thinking.
- Dockeray, Floyd C.: American psychologist who has investigated the various phases of fatigue\*. Author of *General Psychology* (1936).
- Ebbinghaus, Hermann (1850-1909): German scientist, the first to study memory\* experimentally. He developed the nonsense\* syllable as a tool and was the first to study retention\*. His curve of retention was the first.
- Fechner, Gustav T. (1801-1887): German physicist who became interested in measuring mental states and who developed methods and reported facts that led to experimental\* psychology. He formulated the notion of the J.\* n. d. unit of sensation (just noticeably different sensations which result from slight changes in the intensity of the stimuli). Fechner found that the J. n. d. sensation varied as the logarithm of the stimulus\*. Father of psychophysics.
- Franz, Shepherd I. (1874-1935): Physiological\* psychologist who initiated the study of the recovery of function after brain lesions\* in animals. His work was continued by K. S. Lashley\*. Author, with Kate Gordon, of *Psychology*, an introductory text (1933).
- Freud, Sigmund (1856-1939): Founder of psychoanalysis\* as a treatment of the psychoneuroses\*. Freud's theory rests upon the assumption that old memories\* persist in the unconscious\*, where they may still produce symptoms of abnormality\* without the patient's knowledge of them. The process of psychoanalysis is to discover their nature by questioning. The discovery of these memories usually is beneficial to the mental health of the patient. Freud also used the unconscious to explain dreams and the mistakes of everyday life. The hidden complexes\* are mostly sexual in origin, although the term "sexual" must be broadly interpreted.

- Galen (born 131 A.D.): Roman physician of Greek origin, who classified the knowledge of his day and who experimented upon animals to study anatomy and physiology. His statements were for centuries the accepted doctrines. To psychology he contributed theories of personality\* and emotions\*.
- Galton, Francis (1822-1911): English scientist among the first experimentalists in England. He studied mental imagery, developed the use of fingerprinting, and the study of individual\* differences. He began the use of statistics\* in psychology, and furthered the knowledge of heredity\*. He initiated the modern eugenics\* movement.
- Gesell, Arnold: American child psychologist. Devised tests for the measurement of the intelligence\* of infants\*, and studied extensively the mental and physical development of the child. He is the author of *Infancy and Human Growth* (1928) as well as of many other treatises and books.
- Guilford, J. P.: American psychologist who has investigated learning\*, attention\*, and introversion-extroversion\*, among other topics. Author of *General Psychology* (1939) and of *Psychometric Methods* (1936).
- Guthrie, E. R.: Prominent, as an American psychologist, in the Behaviorist's\* School of Psychology. Has studied learning by conditioning\* in animals. Author of *Psychology of Learning* (1935) and *Psychology of Human Conflict* (1938).
- Hall, G. Stanley (1846-1924): Founder of the first psychological laboratory in the United States and of the first psychological journal, *The American Journal of Psychology*. His early work was strictly experimental, but later he developed the questionnaire\* method which he applied to studies of childhood\* and of religious beliefs. His two-volume work entitled *Adolescence* (1904) is still referred to extensively.
- Heidbreder, Edna F.: Experimentalist on problems of thought processes. Studied and revised psychological tests of introversion-extroversion\*. Is the author of *Seven Psychologies* (1933), which is a study of modern schools of psychology.
- Helmholtz, Herman von (1821-1894): German physiologist and physicist who contributed greatly to physiological\* psychology. He was the first to measure the speed of the nerve impulse. His

*Physiological Optics* (1856) is still a standard reference for the facts and theories of color and space perception\*. He also experimented in audition\* and developed a widely accepted resonance theory of hearing.

Henning, Hans: German psychologist who investigated the chemical sense modalities\* of smell and taste. His smell prism with its representation of the relations between the basic odors, spicy, flowery, resinous, fruity, foul and burned, is frequently used.

Herbart, Johann F. (1776-1841): German philosopher and educator who profoundly influenced the early development of theoretical and educational psychology. Herbart argued against Kant that psychology is a science\* and even attempted to reduce its laws to mathematical expression. He is best known for the doctrine of apperception\* which holds, when applied to education, that perception\* and learning\* must be founded upon the background of the experience of the pupil.

Hering, Ewald (1834-1918): German physiologist, known for his theory of color vision, which assumes four primary colors, as opposed to the three assumed by Helmholtz\*. He also contributed to a knowledge of visual space and a theory of primary\* memory.

Hippocrates (Fifth century B.C.): Sometimes called the father of scientific medicine. He originated the *Medical Oath* which is still in use. He developed a theory that man can be understood as a composite of four bodily humors: yellow bile, black bile, phlegm, and blood. Much of his treatment in medical practice was to restore the proper balance of these humors. The dominance of each gave a characteristic temperament\*: phlegmatic, melancholic, sanguine, and choleric.

Hollingworth, Harry L.: Experimented on the effects of caffeine and alcohol on mental efficiency. Studied war neuroses\* during the First World War (1917-1918). He has written treatises on thinking, on abnormal\* behavior, on the behavior of the audience, and on applied\* psychology.

Hull, Clark L.: American experimental psychologist of the behaviorist\* school who developed the goal-gradient\* hypothesis (1932) which stated that the elimination of blinds in a maze\* is the result of an increase in the strength of motivation\* as the animal nears the food-box. Hull is also well known for his studies of aptitudes\*, of

the effects of tobacco upon efficiency, and for his books upon hypnotism\* and learning\*.

Hunter, Walter S.: American psychologist who early studied delayed\* reactions in animals and children. More recently he has conducted many experiments on animal learning\*.

Jaensch, Erich R.: German investigator who has studied space perception\*, especially binocular\* vision. He is well known for his theory of *eidetic\** imagery and for the methods which he devised to measure the phenomenon. Author of *Eidetic Imagery* (1930).

James, William (1842-1910): American physiologist, psychologist and philosopher who encouraged the development of general and experimental\* psychology. Possibly best known today for his theory that emotions\* are equivalent to the awareness of bodily changes. He also performed experiments on transfer\* of training (in learning) which yielded results out of harmony with the theory of formal\* discipline. He did much to establish the modern approach to human behavior.

Janet, Pierre: Eminent French neurologist who has devoted his life to the study and treatment of the psychoneuroses\*. Author of *Major Symptoms of Hysteria* (1907), *Psychological Healing* (1925), and many untranslated works in French.

Judd, Charles H.: American psychologist who turned to education. He has developed a theory that transfer\* of training depends upon generalization\*. He has also investigated the psychology of reading.

Jung, Carl Gustav: Swiss psychiatrist\* who stresses the role of racial memories buried in the unconscious\*, as determinants of behavior and of disease symptoms. Also known for his word-association (free\* association) method of detecting guilt and discovering the content of complexes\*. His classification of personalities\* into introverts\* and extroverts\* has been widely used.

Klüver, Heinrich: American physiological\* psychologist who investigates the problem of stimulus equivalence\* with animal subjects. Known also for his investigations on eidetic\* imagery and the effects of the drug mescal upon human behavior.

Köhler, Wolfgang: German psychologist now in the United States and one of the leaders in the Gestalt\* School. Has investigated vowel



qualities, space perception\*, and the intelligence\* of apes, among many other topics. Author of *The Mentality of Apes* (1925), and *Gestalt Psychology* (1929).

Koffka, Kurt (1886-1941): German Gestalt\* psychologist. Koffka has investigated extensively in the field of perception\*, especially the problem of the perception of movement. The author of *Principles of Gestalt Psychology* (1935).

Kraepelin, Emil (1856-1927): German medical man who approached mental disease from the standpoint of experimental\* psychology. Kraepelin was responsible for the classification of the psychoses\* which is now generally in use. He also investigated the curve of work, fatigue\*, and the effects of drugs\* upon behavior\*.

Kretschmer, Ernst: German psychiatrist\* best known for his attempt to show a relationship between body measurements and the functional psychoses\*. He extended the study to assert that normal\* individuals may be classified on the basis of similarity to the forms of insanity they would show should they become psychotic\*. He would divide men into schizothymes\* who resemble schizophrenics\* in their behavior and body builds, and into cyclothymes\* who resemble the circular insanity patients. Author of *Psychology of Men of Genius* (1931) and *Physique and Character* (1925).

Kuhlmann, Frederick (1876-1941): Clinical psychologist who has specialized in the development and administration of standardized psychological tests. He is well known for his work in the development of the Kuhlmann-Anderson tests of intelligence.

Lange, Carl G. (1834-1900): Danish physician who published in 1885 a theory of the emotions\* very similar to James'\* which had been published in 1884, but which Lange had not seen when he published his treatise. Lange placed rather more emphasis upon the circulatory system and respiration, than did James.

Lashley, Karl S.: American physiological psychologist, who has studied the function of the brain-cortex\* of animals in learning and in retention\* of numerous habits\*. These studies led to his *theory of equipotentiality\**, namely, the theory that the brain acts as a whole rather than having specific functions assigned to definite parts of the cortex.



- Lewin, Kurt: German Gestalt\* psychologist, now in the United States, who has developed the topological approach to the study of conflict and frustration in the child. His theory of personality and motivation is also generally known.
- Lipps, Theodor (1851-1913): German psychologist-philosopher who stressed the role of empathy\* in our reactions to objects in space. He asserts that vertical lines, for instance, seem longer than horizontal lines because the beholder puts himself in the place of the lines. Aesthetic appreciation is assumed to be a projection of the self into the stimulating situation.
- Locke, John (1632-1704): English philosopher who insisted that all knowledge is derived through the senses. Mind at birth he considered a *tabula rasa* (clean slate) upon which the senses write. He introduced the doctrine of association\* into English psychology and gave the empirical trend to British thought. His *Essay Concerning Human Understanding* (1690) sets forth his beliefs.
- Maier, Norman R. F.: American psychologist known for his studies of reasoning\* in animals and in man, as well as for the experimental induction of neurotic conditions in animals. Co-author with T. C. Schneirla of *Principles of Animal Psychology* (1935). His studies on artificially induced neuroses\* in the rat are summarized in *Studies of Abnormal Behavior in the Rat* (1939).
- McDougall, William (1871-1938): British psychologist, later active in America. He advanced the hormic\* or purposive explanation of mental life. Wrote *Abnormal Psychology* (1925), *Body and Mind* (1911), *An Introduction to Social Psychology* (1908), and numerous other works. His *Social Psychology* text was almost the last statement of the doctrine that instincts were definite entities.
- McGeoch, John A.: American experimental psychologist who has investigated numerous problems pertaining to the psychology of learning, retention, and forgetting. By quantifying the relationship between the nature of intervening activities and the recall of previously learned material he has extended our knowledge of retroactive inhibition as an important factor in forgetting.
- Mesmer, Anton (1734-1815): Austrian physician who developed methods of treatment by what he called *animal magnetism*, more recently called *mesmerism*. This method anticipated hypnotism\*.

Meumann, Ernst (1862-1915): One of the early workers in the psychology of learning, and author of the *Psychology of Learning* (1913). Later, he became a pioneer in experimental education.

Meyer, Adolph: American psychiatrist\* with psychological interests. Known for his psychobiological approach to psychiatric problems and for his insistence that patients should not merely be classified under the different categories of the psychoses\*, but that each should be studied as an individual.

Meyer, Max: American psychologist, who anticipated Watson\* in writing a completely behavioristic\* theory of psychology. Also known for his work in the psychology of music and for a theory of hearing which did not assume resonators in the cochlea\*.

Mill, James (1773-1836): English philosopher-psychologist who initiated the development of psychology in England. His *Analysis of the Human Mind* (1829) was instrumental in the study of learning by association\*. Mind was considered equivalent to the sum of sensations\*, ideas\*, and feelings\*. His son, John Stuart Mill\*, extended this conception.

Mill, John Stuart (1806-1873): English philosopher-psychologist who influenced Wundt\* and Titchener\* in their descriptive analyses of conscious states. Mill drew an analogy between mental combinations and chemical compounds. Psychology, for him, was "mental chemistry."

Morgan, C. Lloyd (1852-1936): Pioneer in the development of animal\* psychology with his *Animal Life and Intelligence* (1890). Morgan's\* canon, formulated by him, is interpreted to mean that the simplest explanation of a number of possibilities is the one to accept.

Müller, Georg Elias (1850-1934): German psychologist whose chief contribution was his extension of Ebbinghaus'\* studies on memory\*. He devised the memory drum for the accurate presentation of learning materials. He discovered that distributing repetitions is superior to massed practice. He noted also that retroactive\* inhibition is a factor in forgetting\*.

Müller, Johannes (1801-1858): German physiologist who advanced the knowledge of the nervous\* system by experimentation\*. His formulation of the doctrine of Specific\* Nerve Energies, though

modified, still is accepted. His study in the field of visual space perception\* resulted in statements concerning the horopter\*.

Pavlov, Ivan P. (1849-1936): Russian physiologist who developed in psychology the conditioned\* response technique as an objective\* approach to the study of animal and human learning. His observations on experimentally induced "neuroses"\* in dogs preceded all other such researches. His book *Conditioned Reflexes* (1927) is a sourcebook.

Pearson, Karl (1857-1936): English mathematician and statistician who developed the method of correlation\* used in experimental\* psychology. Worked with Galton\* in the study of individual\* differences.

Plato (Born 427 B.C.): Early Greek philosopher whose theory of knowledge emphasized that sensations\* must be supplemented and corrected by ideas\* innate\* within the soul\*. In his *Republic* he recognized the problem of individual\* differences.

Prince, Morton (1854-1929): American medical psychologist and neurologist known for his successful treatment by hypnosis\* of the Beauchamp case. *The Dissociation of a Personality* (1906) describes this famous case of multiple\* personality.

Ribot, Th. (1839-1916): Introduced the early work by Wundt and by the English into France. His philosophical interpretations of and experimental approaches to psychology were greatly influenced by studies of the abnormal. Charcot particularly influenced the development of the new science of psychology in France as introduced by Ribot. Known for his studies on attention, memory, volition, and movement. Formulated the Law of Regression (1881) to characterize the impairment in memory often shown by those in later maturity (senility).

Ruckmick, Christian A.: American psychologist who worked on rhythm\* and music and made various studies of emotional expression. Author of *The Psychology of Feeling and Emotion* (1936).

Seashore, Carl E.: American experimental\* psychologist who has developed the Musical Aptitude\* Tests which bear his name. Author of *The Psychology of Music* (1938).

Sherrington, Charles S.: English physiologist known for his classical studies of the structure and function of the nervous\* system. The concepts\* of levels of neural action and of the synapse\* have been developed by him. His classic studies and their interpretations are included in his *Integrative Action of the Nervous System* (1906).

Spearman, Charles: English statistician and experimental psychologist who has actively investigated the problem of intelligence. By using a special form of the correlation method developed by him, he formulated the Two Factor Theory of Intelligence. Both "g" and "s" function in every intelligent act. Details of his theory are found in Spearman's *The Abilities of Man* (1927).

Spranger, Eduard: German psychologist who maintains that the purpose of psychology is to understand men. For this one must know the nature of the values which each person possesses. On the basis of man's evaluations, which determine his acts, Spranger classifies men into the following groups: aesthetic, religious, social, economic, and theoretical. Author of *Types of Men* (1928).

Stern, William (1871-1938): German child psychologist who suggested (1912) the use of the term "mental quotient" in intelligence\* testing. This suggestion eventually became the "intelligence\* quotient" as devised by Terman\*.

Terman, Lewis: American psychologist who has revised and extended the Binet-Simon\* Intelligence Test. The latest revision was made in 1937. He is also known for his *Genetic Studies of Genius* (1925, 1930), and for his investigations relative to the traits of masculinity and femininity. Terman has studied the factors which make for happiness in marriage.

Thorndike, Edward L.: American pioneer in the development of animal\*, experimental\*, and educational psychology\*. Famous for his studies on animal and human learning and for his formulation of the three laws of trial-and-error\* learning. Author of numerous books and treatises.

Thurstone, L. L.: American psychologist and statistician known for his development of a technique for the measurement of social attitudes\* on controversial issues, as well as for his extensive study of the independent factors which account for a score earned on an



- intelligence\* test. His seven-factor theory of intelligence is discussed in his *Vectors of the Mind* (1935).
- Titchener, Edward B. (1867-1927): English psychologist, trained by Wundt\*, and founder of the Structuralist\* School of psychology in the United States. An eminent teacher and director of research who did much to develop experimental\* psychology in America.
- Tolman, Edward C.: Known for his work in animal\* psychology. He combines the theoretical approaches of the Gestalt\* and the Behaviorist\* Schools in his writings. Author of *Purposive Behavior in Animals and Men* (1932).
- Tredgold, A. F.: English medical authority on feeble-mindedness\*. His text, *Mental Deficiency* (1937), is an excellent source book.
- Valentine, Willard L.: Experimented on learning and developed rules for plotting learning\* curves in animal and human experiments\*. Edited material for *Experimental Foundations of General Psychology* (1941).
- Vaughan, Wayland F.: Experimented on the methods of studying prejudices, and is the author of *General Psychology* (1940).
- Warren, Howard C. (1867-1934): American psychologist and for long the editor of the *Psychological Review*. Author of *A History of Association Psychology* (1921), *Elements of Human Psychology* (with Leonard Carmichael in 1930), and a *Dictionary of Psychology* (1934).
- Washburn, Margaret F. (1871-1939): Pioneer in the development of comparative psychology\* in America, advocate of the theory that all mental life can be explained in terms of motor responses. Author of *The Animal Mind* (1908).
- Watson, John B.: American psychologist who founded the school of Behaviorism\* (1913). He emphasized the objective\* method of observation in psychological investigations. Known also for his study of the emotional reactions of infants\*. His *Psychology From The Standpoint of a Behaviorist* (1929) sets forth the basic tenets of his thought.
- Weber, Ernst H. (1795-1878): German physiologist who formulated the law which bears his name. Weber's\* Law states that the least noticeable difference between two sensations, within the same sense



mode, is always a constant fraction of the first stimulus\* value. He also worked on space sensitivity of the skin and on the nature of kinaesthetic\* sensations.

Wertheimer, Max: German psychologist who founded the modern Gestalt\* School (1912). His experiments on the visual perception of movement (Phi\* Phenomenon) were instrumental in the development of the school. Wertheimer is also known for his theory of thinking.

Woodrow, Herbert H.: American psychologist who has experimented extensively in the field of time, rhythm\*, and attention\*. He also demonstrated that the amount of transfer\* in memory training depends upon the method of teaching. Author of *Brightness and Dullness in Children* (1919).

Woodworth, Robert S.: American psychologist who experimented on the control of movement, especially on transfer\* of training of motor accuracy. He also was an early advocate of imageless thought. He represents the stimulus-response\* school in psychology. Author of several textbooks, and of the sourcebook, *Experimental Psychology* (1938).

Wundt, Wilhelm (1832-1920): Known as the father of experimental\* psychology and the founder at Leipzig in 1879 of the first psychological laboratory. He trained many of the early experimenters, and formulated the results of early psychological investigations into several comprehensive volumes.

Yerkes, Robert M.: American psychologist who pioneered in the comparative study of animals, with particular emphasis recently upon the behavior of the higher apes. The Yale University Anthropoid Research Station at Orange Park, Florida, is a center for these studies. Known also for the development of the point\* scale intelligence\* test.

Young, P. T.: American experimental psychologist known for his studies in motivation and for the *pseudophone* study. By means of headphones each of which carried sound waves to the ear more distant from the sounding object, Young found reversals in his localizations of sound in space. When he saw the object and heard the sound, localization was normal. This study shows that auditory localization, as a perceptual act, is a function of the eye as well as the ear.

PART FOUR

Reference Books in General  
Psychology

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## PART FOUR

### Reference Books in General Psychology

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The following titles are either standard texts in general psychology or standard reference works.

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- Allport, G. W., *Personality: A Psychological Interpretation*. Holt, 1937. Pp. 588.
- Bills, A. G., *General Experimental Psychology*. Longmans, Green, 1934. Pp. 620.
- Boring, E. G., Langfeld, H. S., and Weld, H. P., *Introduction to Psychology*. Wiley, 1939, Pp. 652.
- Butler, J. R., and Karwoski, T. F., *Human Psychology*. Pitman, 1936. Pp. 447.
- Cole, L. E., *General Psychology*. McGraw-Hill, 1939. Pp. 688.
- Crafts, L. W., Schneirla, T. C., et al., *Recent Experiments in Psychology*. McGraw-Hill, 1938. Pp. 417.
- Dashiell, J. F., *Fundamentals of Objective Psychology*. Houghton Mifflin, 1928. Pp. 588.
- Dashiell, J. F., *Fundamentals of General Psychology*. Houghton Mifflin, 1937. Pp. 655.
- Davis, R. A., *The Psychology of Learning*. McGraw-Hill, 1935. Pp. 489.
- Dockeray, F. C., *General Psychology* (Revised edition). Prentice-Hall, 1936. Pp. 576.
- Dunlap, Knight, *Elements of Psychology*. Mosby, 1936. Pp. 499.
- English, H. B., *A Student's Dictionary of Psychological Terms*. Harper, 1934. Pp. 131.

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- Freeman, E., *Principles of General Psychology*. Holt, 1939. Pp. 530.
- Garrett, H. E., *Great Experiments in Psychology* (Revised edition). Appleton-Century, 1941. Pp. 452.
- Gates, Arthur, *Elementary Psychology*. Macmillan, 1929. Pp. 612.
- Gilliland, A. R., Morgan, J. J. B. and Stevens, S. N., *General Psychology*. Heath, 1935. Pp. 462.
- Goodenough, F., *Developmental Psychology*. Appleton-Century, 1934. Pp. 619.
- Grabbe, Paul, *We Call It Human Nature*. Harper, 1939. Pp. 120.
- Griffith, C. R., *Introduction to Applied Psychology*. Macmillan, 1934. Pp. 679.
- Griffiths, J. H., *The Psychology of Human Behavior*. Farrar and Rinehart, 1936. Pp. 515.
- Guilford, J. P., *General Psychology*. Van Nostrand, 1939. Pp. 630.
- Guthrie, E. R., *The Psychology of Learning*. Harper, 1935. Pp. 258.
- Guthrie, E. R., *The Psychology of Human Conflict*. Harper, 1938. Pp. 408.
- Heidbreder, E., *Seven Psychologies*. Century, 1933. Pp. 450.
- Higginson, G. D., *Fields of Psychology*. Holt, 1931. Pp. 613.
- Higginson, G. D., *Psychology*. Macmillan, 1936. Pp. 646.
- Hilgard, E. R., and Marquis, D. G., *Conditioning and Learning*. Appleton-Century, 1940. Pp. 429.
- Hoisington, L. B., *Psychology: An Elementary Text*. Macmillan, 1935. Pp. 557.
- Husband, R. W., *General Psychology*. Farrar and Rinehart, 1940. Pp. 513.
- Klineberg, O., *Race Differences*. Harper, 1935. Pp. 367.
- Klineberg, O., *Social Psychology*. Holt, 1940. Pp. 570.
- Lund, F. H., *Psychology*. Ronald Press, 1933. Pp. 475.
- Maier, N. R. F., and Schneirla, T. C., *Principles of Animal Psychology*. McGraw-Hill, 1935. Pp. 529.
- Morgan, J. J. B., *Psychology*. Farrar and Rinehart, 1941. Pp. 612.
- Murphy, G., *A Briefer General Psychology*. Harper, 1935. Pp. 572.
- Penrose, L. S., *Mental Defect*. Farrar & Rinehart, 1934. Pp. 205.
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- Rexroad, C. N., *Psychology and Personality Development*. Christopher, 1940. Pp. 501.
- Robinson, E. S., and Robinson, F. R., *Readings in General Psychology*. Chicago Univ. Press, 1923. Pp. 674.
- Ruch, F. L., *Psychology and Life* (Revised edition). Scott, Foresman, 1941. Pp. 732.
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- Stroud, J. B., *Introduction to General Psychology*. Prentice-Hall, 1938. Pp. 681.
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